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SECTION 1 Executive Summary

Tulu Kapi Gold Project
Definitive Feasibility Study
July 2015

Golder Associates

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SNOWDEN

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1.1 INTRODUCTION AND PROJECT BACKGROUND

Small-scale surface mining took place at Tulu Kapi in the 1930s focussing on easily accessible gold-bearing saprolite on the flanks of the Tulu Kapi deposit. The earliest modern exploration of the Tulu Kapi area took place in the 1970s under the guidance of the United Nations Development Project (UNDP), which undertook reconnaissance exploration over a wide area of western Ethiopia between 1969 and 1972.

The Tulu Kapi Exploration Licence was granted to Minerva Resources through its wholly owned subsidiary GPMC in May 2005, prior to the acquisition of the Project by Dwyka Resources Limited (subsequently renamed to Nyota Minerals Ethiopia Limited or NME) in August 2009.

Various studies were undertaken during the period of 2010 to 2011 to investigate the feasibility of alternative cyanidation process routes to recover the gold from the Tulu Kapi ore. Further extensive exploration and drilling allowed Nyota to complete a Definitive Feasibility Study (Nyota 2012 DFS) in December 2012 based on a 2 Mtpa processing plant and annual production of 105 000 ounces of gold. KEFI acquired 100 % project ownership from Nyota in two tranches – 75 % in December 2013 and the remaining 25 % in September 2014. The Government of Ethiopia is entitled to a 5 % free-carried interest.

KEFI acquired the project with the intention to refine the Nyota 2012 DFS. This process has methodically overhauled the technical and economic characteristics of the Tulu Kapi Gold Project. KEFI's Definitive Feasibility Study (DFS) is based on constructing a conventional 1.2Mtpa carbon-in-leach (CIL) processing plant and introducing selective mining to increase the planned gold grade of open-pit ore mined. This approach significantly reduces the capital required and increases the project returns

1.2 PROPERTY DESCRIPTION AND LOCATION

The Tulu Kapi Gold Project is located in Western Ethiopia, in the Western Wellega Zone of the Oromia Region approximately 360 km due west of the capital, Addis Ababa (Figure 1-1). The Project is accessible by main road from Addis Ababa, a distance of 520 km with the final 15 km by means of an all-weather unpaved road running through surrounding villages. The journey by road from Addis Ababa to Tulu Kapi takes approximately 10 hours.

The project area is about 9 km south of the village of Kelley, which is on the main Gimbi to Dembi Dollo road. Regional population centres within easy road travel distance of the licence areas include Ayra, a small town about 20 km to the west, Gimbi, an important market town about 32 km to the east northeast, and Nekemte, a larger regional centre about 110 km to the east.

The project site is located on a ridge forming a watershed which drains north and south. Drainage to the north is towards the Gurach and Kersa Rivers which are sub-tributaries of the Birbir River. Drainage to the south is via the Chalte, Kumbo and Sarere rivers which are sub tributaries to the Baro and Blue Nile Rivers. The streams in the area are perennial but reduce to

very low flow rates in the dry season. Groundwater in the project area is found in two aquifers. The upper unconfined aquifer is located in the saprolite and the lower semi-confined aquifer is located deeper in the fractured bedrock. Groundwater flow is expected to mimic the surface topography and be controlled by surface water divides.
Land use is predominantly agricultural and the ridges are mainly left to grass for cattle. The hill sides are terraced for seasonal cropping of maize, teff, corn, and other staples. The incised valleys are overprinted by a forest ecosystem providing shade for coffee plantations.

Rainfall is seasonal with a pronounced "monsoon" period between July and September. Daily average high and low temperatures range from 32 °C and 13 °C in May immediately prior to the start of the wet season, to 24 °C and 14 °C in July and August which are the coldest months.

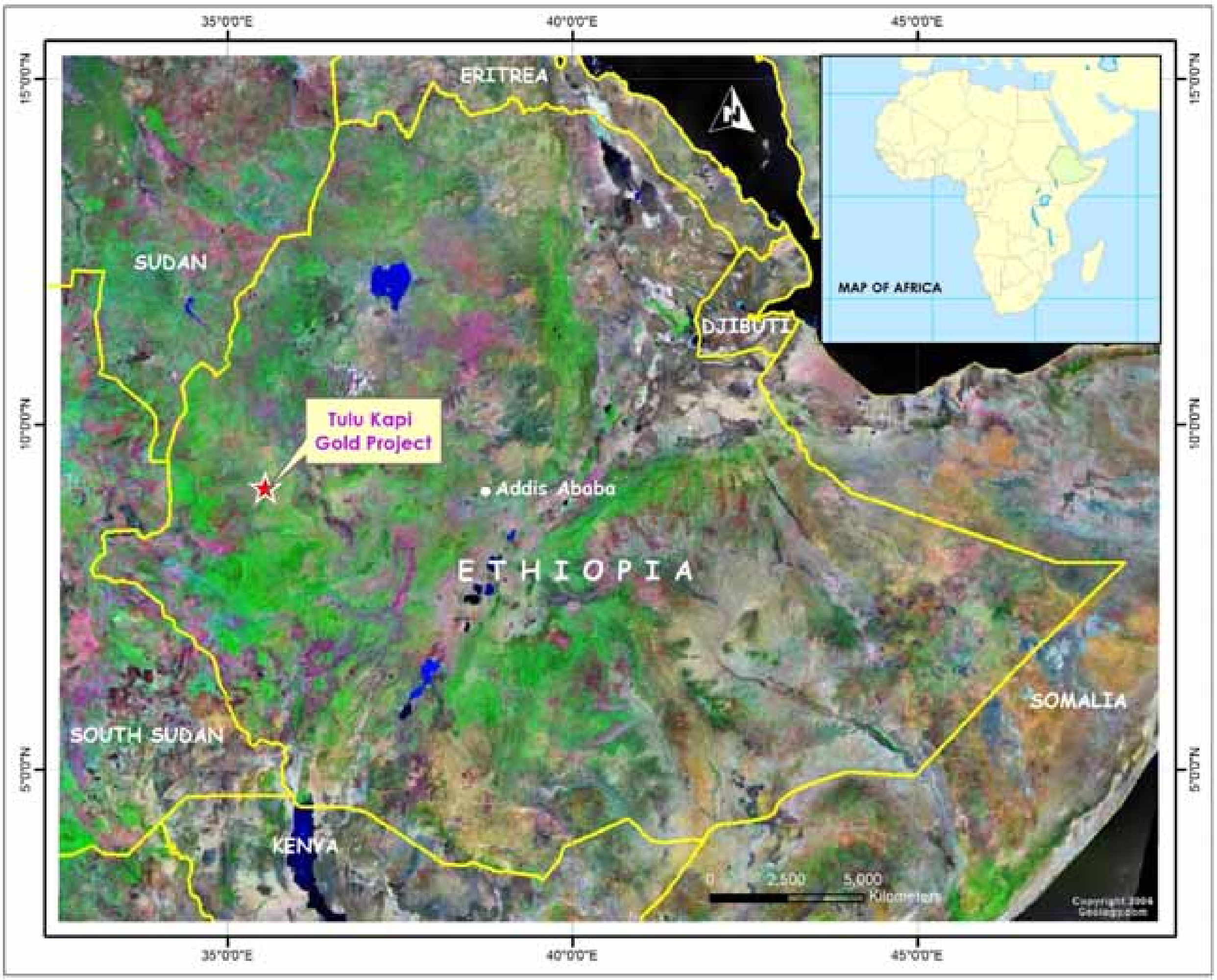


Figure 1-1: Tulu Kapi Gold Project Location

1.3 GEOLOGY, MINERALISATION AND EXPLORATION

Western Ethiopia lies within the Arabian-Nubian Shield which consists of Upper Proterozoic rocks (more than 800 Ma) and is best described as a granite-greenstone terrain. Additional weakly metamorphosed volcano-sedimentary successions of late Proterozoic age (more than 570 Ma) occur within the same terrain. The area has been extensively folded, faulted and intruded by Pan-African aged granites (500 Ma) and lesser mafic to ultramafic intrusives and hosts a number of gold occurrences/deposits. These rocks outcrop in the north, west and south of Ethiopia and also underlie most of Eritrea and northern parts of Sudan.

The Tulu Kapi gold project is located in western Ethiopia approximately 350 km due west of the capital, Addis Ababa. Access to the project is by road and involves a 10-hour road trip on sealed and unsealed roads from Addis Ababa to the project site.

The gold mineralisation at Tulu Kapi is hosted by an Upper Proterozoic age intrusive, which comprises a coarse grained syenite pluton. These rocks have been intruded into a volcano-sedimentary sequence that was subsequently transformed to mafic and sericitic schists. The main Tulu Kapi deposit comprises a series of stacked gold-bearing quartz-carbonate veins, veinlets and stock work intimately associated with sub-horizontally dipping albite alteration zones.

The earliest formal exploration of the Tulu Kapi area took place in the 1970s under the guidance of the UNDP. The work was largely reconnaissance level and regionally based and included stream sediment and soil geochemical sampling programs, geophysical surveys, detailed geological mapping, and diamond drilling.

Tan Range Exploration Company ("TREC"), a Canadian registered company, acquired an exploration licence over an area that incorporated the current Tulu Kapi licence and undertook further exploration between 1996 and 1998. The Tulu Kapi – Ankore Exploration Licence (Tulu Kapi or Tulu Kapi Licence) was granted to Minerva Resources through its wholly owned subsidiary, Golden Prospect Mining Company ("GPMC") on 27 May 2005.

Minerva Resources (GPMC's parent company) was acquired by Dwyka Resources Limited (now Kefi Minerals Limited) in July 2009, making GPMC a wholly owned subsidiary. Following this acquisition an aggressive exploration program commenced, comprising some early trenches (14), exploration/resource definition drilling and infill resource drilling using both diamond drilling and RC drilling.

KEFI Minerals Plc acquired 75% of the share capital of Kefi Minerals (Ethiopia) Ltd ("NME"), the owner of the Tulu Kapi Project and surrounding exploration licences, in December 2013. KEFI announced the acquisition of the remaining 25% of KME in June 2014 and this acquisition was approved in September 2014.

1.4 MINERAL RESOURCES

The Mineral Resource was estimated by Snowden, as part of this feasibility study, is based on 118,700 m of diamond drilling, reverse circulation ("RC") drilling and trenching completed by both the current and previous owners of the project. The drilling data used in compiling the Mineral Resource estimate is summarised in Table 1-1.

Table 1-1: Summary of Drilling Data

Company	Years	Drilling Method	Number of Drill Holes	Metres Drilled
TREC, GPMC, Nyota, KEFI	1996 to 2014	Diamond	298	72 033
		RC	342	45 611
		Trench	82	1 094
Total			**722**	**118 738**

The Mineral Resource has been classified and reported in accordance with the JORC Code (2012) using a 0.45 g/t Au cut-off grade for potential open pit resource above the 1400 mRL and a 2.5 g/t Au cut-off grade for potential underground resource below the 1400 mRL. A summary of the Tulu Kapi Mineral Resource estimate is listed in Table 1-2.

Table 1-2: Tulu Kapi Mineral Resource estimate reported above a 0.45 g/t Au cut-off and 2.5 g/t Au cut-off

JORC (2012) Resource category	Reporting elevation	Cut-off (g/t Au)	Tonnes (Mt)	Au (g/t)	Ounces (million)
Indicated	Above 1400 RL	0.45	17.7	2.49	1.42
Inferred	Above 1400 RL	0.45	1.28	2.05	0.08
Indicated and Inferred	**Above 1400 RL**	**0.45**	**19.0**	**2.46**	**1.50**
Indicated	Below 1400 RL	2.50	1.08	5.63	0.20
Inferred	Below 1400 RL	2.50	0.12	6.25	0.02
Indicated and Inferred	**Below 1400 RL**	**2.50**	**1.20**	**5.69**	**0.22**
Total Indicated	All		18.8	2.67	1.62
Total Inferred	All		1.40	2.40	0.10
Total Indicated and Inferred	**All**		**20.2**	**2.65**	**1.72**

1.5 ORE RESERVES AND MINING

In January 2015, Snowden Mining Industry Consultants ("Snowden") was retained by KEFI Minerals Ethiopia ("KEFI") to compile the mining study section for the Tulu Kapi ("Tulu") Gold Project Feasibility Study. The purpose of the work was to use the updated February 2015 Mineral Resource estimate and update the mine plans that were previously developed in October 2014 as part of the Tulu Kapi Ore reserve estimate.

1.5.1 Key Strategic Issues

The key mining related items facing the project are:

- The impact of dilution that will result from the mining process
- The effective implementation of a selective mining cycle that minimises dilution including:
    - Blasting products and methods that minimise movement and mixing that will cause dilution
    - Using reduced sized blasts and bench heights to assist in separating isolating the ore and waste
    - Using appropriate size machines with smaller buckets 6.7 m3 to increase the digging selectivity of the ore whilst maintaining a reasonable production rate.

1.5.2 Reliance on External Work

Snowden is reliant on work undertaken by other parties relating to non-mining issues including:

- Hydrology (surface and ground water)
- Metallurgy (process recovery)
- Geotechnical (pit slopes)
- Processing infrastructure (operating and capital costs)
- Marketing (metal pricing)
- Lease, environmental and cultural restrictions.

Snowden also used the following studies that were completed by Snowden in early 2015 as a basis for its mine planning studies:

- Tulu Kapi Mineral Resource Report. Internal report submitted to KEFI Minerals PLC. February 2015.
- Tulu Kapi Feasibility Study Geotechnical Assessment. Internal report submitted to KEFI Minerals PLC. May 2015.

Mobile plant pricing was predominantly provided by the local Ethiopian Komatsu distributor and modelled against productivity, resulting in comprehensive unit mining operating cost and capital cost estimation. Comprehensive mining costs were developed by Mine and Cost Engineering Pty Ltd. Other indirect mining costs including infrastructure were developed by KEFI and accepted by Snowden as part of the economic assessment.

Snowden also assessed the KEFI-developed financial model to understand the economic viability of the project. Snowden relied on gold price of US$1250 per oz as provided by KEFI. Snowden also relied on documents by KEFI and its consultants (provided by KEFI) which indicate that there are no environmental, approvals, licensing or permitting encumbrances hindering the estimation of Ore Reserves.

1.5.3 Mine Planning

The mine planning work and Ore Reserve estimate was completed over a four-month period from February to May 2015. This took into account the wire-framing of the individual ore lodes and the current mine planning inputs and thus superseded the mine planning and Ore Reserve estimate completed in 2014. No site visit was undertaken by the Snowden Competent Person for Ore Reserves; instead, site visits was undertaken by a Snowden geologist for the Mineral Resource sign-off and the Tulu project metallurgist who was the Competent Person for the metallurgy and process sign-off. The Snowden Competent Person for Ore Reserves has relied on this site visit for confirmation of the existence of an Ore Reserve at Tulu Kapi.

Following a mine planning process, the following items were produced by Snowden:

- A planned ore dilution assessment for the Tulu Kapi ore mineralisation that provided a diluted model with a 6% decrease in gold metal and a 6% increase in the ore tonnage at a cut-off of 0.9 g/t Au
- Potential economic pit limits, identifying an ultimate surface for ore and waste extraction inclusive of 12.24 Mt of ore at cut-off of 0.9 g/t, with a grade of 2.49 g/t for 0.98 Moz insitu
- Pit designs using feasibility study geotechnical constraints that were developed by Snowden. The final pit contained (exclusive of ore losses):
    - Ore 12.7 Mt
    - Gold grade 2.52 g/t
    - Gold metal (insitu) 1.03 Moz
    - Waste 121.5 Mt
    - Total tonnes 134.2 Mt
- Production scheduling that resulted in a viable supply of ore with a cut-off grade of 0.5 g/t at a rate of approximately 1.2 million tonnes ("Mt") per annum to the proposed Tulu plant for 12.2 years. The schedule physicals were reported exclusive of the quarry pit movements and inclusive of a 5% ore loss. The final mine production inventory provided:
    - Processed ore 15.4 Mt
    - Gold grade 2.12 g/t
    - Gold metal recovered 960 Koz
    - Waste mined 114.2 Mt
    - Total tonnes 129.5 Mt
- Cost modelling to provide production scheduling with haulage paths and cycle times.

The final pit design and infrastructure layout is provided in Figure 1-2. An asymmetric view of the pit in the final surface is provided in Figure 1-3.

Figure 1-2: Final pit design and infrastructure layout

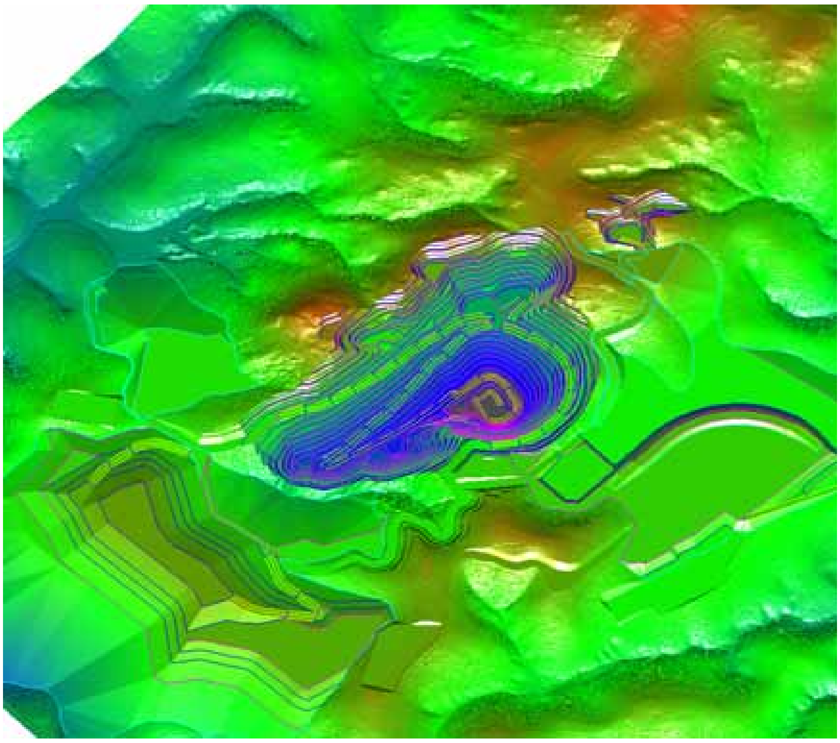


Figure 1-3: Final surface northwest symmetric

1.5.4 Ore Reserve estimate

The key Modifying Factors used to estimate the Tulu Kapi Ore Reserve are based on the experience of Snowden and KEFI employees in this type of deposit and style of mineralisation. Section 4 of this report summarises the status of material aspects of the September 2014 Tulu Kapi Ore Reserve estimate, in the context of the JORC Code (2012) Table 1, Section 4 Checklist of Assessment and Reporting Criteria. Section 2 of this report also includes the Competent Person sign-offs for the Tulu Kapi Ore Reserve.

The Tulu Kapi Ore Reserve estimate is in accordance with the JORC Code (2012) and the Ore Reserve for the Tulu Kapi deposit as at September 2014 is summarised in Table 1-3.

Table 1-3: April 2015 Tulu Kapi Ore Reserve Estimate Reported above a 0.5 g/t Au Cut-off Grade

JORC (2012) Reserve category	Cut-off (g/t Au)	Tonnes (Mt)	Au (g/t)	Ounces (Moz)
Probable – High grade	0.90	12.0	2.52	0.98
Probable – Low grade	0.50 to 0.90	3.3	0.73	0.08
Total		**15.4**	**2.12**	**1.05**

Note: Mineral Resources are inclusive of Ore Reserves. Numbers are reported to three significant figures. Small discrepancies may occur due to the effects of rounding.

All references to currency in this report are in United States of America dollars ("US$").

1.5.5 Mining schedule

A mine production schedule was achieved with a three month pre-production period in year -1, and a process rate of 1.1 Mtpa in year 1 and a mill capacity of 1.2 Mtpa being reached in year 2 for the mill life of 13.3 years. The process schedule for the three different ore type is summarised annually in Table 1.4.

Table 1.4 Process and Metal Schedule

	Period	-1	1	2	3	4	5	6	7	8	9	10	11	12	13
Process															
Saprolite (kt)	937		362	59	29	24	0	23			16	158	3	0	261
- Grade – Au (g/t)	1.56		2.08	2.93	2.70	1.59	1.33	1.40			1.15	1.13	1.05	0.75	0.70
Fresh (kt)	10,091		738	1,141	1,171	1,057	1,200	781	244	176	587	691	1,034	1,200	71
- Grade – Au (g/t)	1.99		1.92	3.46	2.98	2.17	2.83	2.16	3.01	1.16	1.08	1.00	0.73	0.69	0.67
Hard (kt)	4,365					118		396	956	1,024	597	350	163		761
- Grade – Au (g/t)	2.54					3.82		3.09	2.80	2.95	3.54	2.60	0.95		0.70
Total (kt)	15,393		1,100	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,093
- Grade – Au (g/t)	2.12		1.97	3.44	2.97	2.32	2.83	2.45	2.84	2.68	2.30	1.48	0.76	0.69	0.70
Metal															
Mined - Au (koz)	1,047	4	83	191	136	76	129	95	129	104	68	29	1		
Feed - Au (koz)	1,050		70	133	115	90	109	95	110	104	89	57	29	27	25
Recovered - Au (koz)	960		65	123	106	82	101	86	99	93	80	52	26	24	22

1.5.6 Mining Equipment

The mining equipment proposed for the project is given in Table 1-5.

Table 1-5 : Mining Fleet Requirements

Description	Units	Max
Primary fleet		
Excavator 200 t	No	3
Excavator 120 t	No	1
Trucks 90 t	No	13
Blast Hole Drills	No	2
RC drills	No	4
Ancillary fleet		
Track dozer	No	2
Wheel dozer	No	1
Grader	No	2
Watercart	No	2
Batter digger	No	1
Rockbreaker	No	1
Stemming Truck	No	1
Lighting tower provision	No	6
Fuel and Lube truck	No	1
Other		
Minor Equipment	No	9
Light vehicles (incl buses)	No	21

1.5.7 Mining Capital and Operating Costs

Capital and operating costs were estimated from vendor quotations sourced specifically for the project. Operating cost consider plant, labour, material and contractor costs and covered all activities associated with the pit operations including clearing the site, drill and blast, load and haul and rehabilitating the waste dumps. Capital costs included the scheduled procurement of the equipment described in Section 1.5.6 and where appropriate the replacement of that equipment to maintain reasonable average age of machines across the fleet. Costs were allocated to capital development where they were incurred during a pre-production.

The mining capital and operating costs detailed in this DFS are predicated on an owner mining approach. However, KEFI is likely to take utilise contract mining instead. Preliminary submissions from mining contractors have been utilised in assessing the financial outcomes of a contract mining approach in Section 16 of this DFS.

A summary of the Tulu Kapi mining operations is given in Table 1-6.

Table 1-6: Tulu Kapi Mining Operations Summary

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Ore From Borrow + Mine																		
Oxide Ore	Mt	0.012	0.137	0.495	0.145	0.064	0.000	0.001	0.014	-	-	-	0.066	0.002	-	-	-	0.937
Grade - Au	g/t	1.69	1.41	1.53	1.85	1.72	3.58	0.72	1.24	-	-	-	1.29	1.09	-	-	-	1.56
Fresh Ore	Mt	0.002	0.016	1.298	2.550	2.005	0.980	1.909	0.793	0.425	-	-	0.089	0.024	-	-	-	10.091
Grade - Au	g/t	2.14	1.73	1.41	2.22	2.06	1.91	2.10	1.97	2.09	-	-	1.27	1.46	-	-	-	1.99
Fresh Hard	Mt	-	-	-	-	-	0.172	-	0.601	1.475	1.311	0.636	0.171	-	-	-	-	4.365
Grade - Au	g/t	-	-	-	-	-	2.91	-	2.32	2.13	2.46	3.33	4.14	-	-	-	-	2.54
Total	**Mt**	**0.015**	**0.153**	**1.793**	**2.695**	**2.069**	**1.153**	**1.910**	**1.407**	**1.900**	**1.311**	**0.636**	**0.327**	**0.026**	**-**	**-**	**-**	**15.393**
Grade - Au	**g/t**	**1.76**	**1.44**	**1.44**	**2.20**	**2.05**	**2.06**	**2.10**	**2.11**	**2.12**	**2.46**	**3.33**	**2.78**	**1.43**	**-**	**-**	**-**	**2.12**
Processing																		
Oxide Ore	Mt	-	-	0.362	0.059	0.029	0.024	0.000	0.023	-	-	0.016	0.158	0.003	0.000	0.261	-	0.937
Grade - Au	g/t	-	-	2.08	2.93	2.70	1.59	1.33	1.40	-	-	1.15	1.13	1.05	0.75	0.70	-	1.56
Fresh Ore	Mt	-	-	0.738	1.141	1.171	1.057	1.200	0.781	0.244	0.176	0.587	0.691	1.034	1.200	0.071	-	10.091
Grade - Au	g/t	-	-	1.92	3.46	2.98	2.17	2.83	2.16	3.01	1.16	1.08	1.00	0.73	0.69	0.67	-	1.99
Fresh Hard	Mt	-	-	-	-	-	0.118	-	0.396	0.956	1.024	0.597	0.350	0.163	-	0.761	-	4.365
Grade - Au	g/t	-	-	-	-	-	3.82	-	3.09	2.80	2.95	3.54	2.60	0.95	-	0.70	-	2.54
Total	Mt	**-**	**-**	**1.100**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.093**	**-**	**15.393**
Grade - Au	g/t	**-**	**-**	**1.97**	**3.44**	**2.97**	**2.32**	**2.83**	**2.45**	**2.84**	**2.68**	**2.30**	**1.48**	**0.76**	**0.69**	**0.70**	**-**	**2.12**
Construction Borrow	Mt	1.012	3.455	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.467
Waste Movement	Mt	-	0.647	9.849	13.027	16.431	17.347	16.590	17.093	12.316	6.262	3.143	1.435	0.060	-	-	-	114.200
Ore Movement	Mt	-	0.103	1.793	2.695	2.069	1.153	1.910	1.407	1.900	1.311	0.636	0.327	0.026	-	-	-	15.329
Total Material Movement	**Mt**	**1.012**	**4.205**	**11.642**	**15.721**	**18.500**	**18.500**	**18.500**	**18.500**	**14.216**	**7.573**	**3.779**	**1.761**	**0.086**	**-**	**-**	**-**	**133.995**
Stockpile Reclaim	Mt	-	-	0.103	-	0.209	0.525	0.052	0.284	0.015	0.203	0.645	0.903	1.174	1.200	1.093	-	6.406
Operating Cost	$M	-	-	25.771	33.100	40.449	42.079	44.176	44.293	41.255	27.163	18.679	13.020	5.017	3.462	3.378	1.307	343.149
Capital Development	$M	3.234	10.051	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13.285
Capital Equipment	$M	16.323	9.211	11.714	6.138	1.268	4.363	0.082	0.082	0.155	0.346	0.673	0.123	0.232	-	-	-	50.710
Total Mining Cost	**$M**	**19.556**	**19.262**	**37.485**	**39.238**	**41.716**	**46.442**	**44.259**	**44.376**	**41.410**	**27.508**	**19.352**	**13.143**	**5.249**	**3.462**	**3.378**	**1.307**	**407.144**
Unit operating cost	$/t.rock	-	-	2.21	2.11	2.19	2.27	2.39	2.39	2.90	3.59	4.94	7.39	58.36	-	-	-	2.56
Unit capital cost	$/t.rock	19.33	4.58	1.01	0.39	0.07	0.24	0.00	0.00	0.01	0.05	0.18	0.07	2.70	-	-	-	0.48
Total unit mining cost	**$/t.rock**	**19.33**	**4.58**	**3.22**	**2.50**	**2.25**	**2.51**	**2.39**	**2.40**	**2.91**	**3.63**	**5.12**	**7.46**	**61.06**	**-**	**-**	**-**	**3.04**

1.6 METALLURGICAL TESTWORK AND PROCESS PLANT

1.6.1 Introduction

Metallurgical testwork was carried out on various samples of oxide and fresh Tulu Kapi ore types for the Pre-Feasibility Study (PFS), and the results were detailed in ALS AMMTEC's final report (A12931) dated September 2011.

This testwork, which included a mineralogical study of the Tulu Kapi ore, investigated the comminution requirements as well as the alternative process routes of flotation, gravity recovery and cyanidation leaching for gold recovery.

Further testwork was initiated in January 2012 and completed in July 2012 as part of the Nyota Minerals' Definitive Feasibility Study (Nyota 2012 DFS) to confirm gold recovery efficiencies through a combination of gravity separation and cyanidation leaching as well as tailings detoxification and additional comminution testwork to support the process design parameters for a conventional gold recovery plant.

The recovery of associated silver values was monitored throughout the testwork to investigate the potential effect on gold recovery and with a view to predicting the anticipated silver content in the doré that will be produced.

Samples for this testwork were provided in various separate lots:

- A bulk composite of fresh ore sample remnants from the earlier PFS testwork used to support initial process design parameters for the CIL circuit.
- Core samples of the various ore types selected from the intersects of one, new and centrally located borehole specifically chosen to target the full range of ores, from oxide to shallow fresh ore (Lode 1) down to the harder fresh ore (Lode 3) for both comminution and extraction testwork .
- Core samples from several shallow depth holes to provide sufficient quantities of competent oxide ore suitable for comminution testwork and extraction variability testwork.
- Saprolite oxide core and pit samples for extraction variability testwork.
- Quarter-core fresh ore samples from selected existing boreholes to allow for a comprehensive variability study of both comminution and leach extraction data.

ALS Ammtec (AMMTEC) was appointed to carry out the testwork programme.

Orway Mineral Consultants (OMC) was appointed to review the PFS testwork results and to manage the Nyota 2012 DFS testwork programme.

A value engineering exercise was also conducted by SENET in 2014 to examine the gravity concentration and oxygen uptake testwork with the objective of reducing the process flowsheet to what is essential for gold recovery. The following was investigated:

- Removal of the gravity circuit if conventional cyanide leaching recovered sufficient gold
- Kinetics and gold extraction efficiencies achieved using air sparging in the leaching circuit

1.6.2 Testwork Results and Observations

The results of the testwork from both the PFS and the DFS campaigns are summarised in Section 6.

These results indicated the following:

- The oxide and transitional ores are of medium hardness and fresh ore becomes harder with increasing depth.
- All the ore types (oxides and fresh) are amenable to gold extraction by conventional cyanidation.
- Leach dissolutions of 97.4 % and 96.4 % were obtained for oxides and deep hard fresh, respectively at a grind size of P_{80} of 75 µm in a leach time of 24 hours.
- Recovery testwork with and without gravity separation showed that gravity separation did not significantly increase overall gold recovery. Therefore run-of-mine cyanidation was the selected process route.
- Leach optimisation testwork showed the following optimum parameters:

    - Optimum grind: 80 % passing 75 µm
    - Optimum initial cyanide concentration: 0.035 % NaCN
    - Presence of preg-robbers: 1.75 % therefore CIL circuit selected
    - Residence time: 24 hours

Table 1-7 shows a summary of the testwork results. These results or outcomes were used in developing the process flowsheet and the design criteria.

Table 1-7: Summary of the Testwork Results

Comminution Testwork	Unit or Type	Oxide Comp	Fresh Comp Lode 1	Fresh Comp Lode 2
Abrasion Index	g	0.3139	0.3898	0.6522
BRWi	kWh/t	11.3	12.2	19.7
BBWi (106 µm)	kWh/t	15.5	15.5	18
JK Drop Weight	A × b	111.9	81.8	38.6
	ta	1.07	0.72	0.29
Leach Optimisation Testwork	Optimum grind	80 % - 75 µm		
	Optimum cyanide addition	0.0035 % NaCN maintained		
	Preg robbers (oxides)	1.75 % therefore CIL circuit		
	Optimum residence time (h)	24		
Gold Dissolution	Oxide (%)	97.4		
	Deep Fresh (%)	96.4		

Comminution Testwork	Unit or Type	Oxide Comp	Fresh Comp Lode 1	Fresh Comp Lode 2
Cyanide Consumption	Oxide (kg/t)	0.28		
	Deep Fresh (kg/t)	0.13		
Oxygen Uptake	Oxides (mg/L/min)	0.018		
	Fresh (mg/L/min)	0.008		
Carbon Loading Kinetics and Equilibrium	Carbon loading -Oxides (g/t Au)	6864		
	Carbon loading - Fresh (g/t Au)	3502		
Cyanide Detoxification	Selected Process	INCO		
	Residual cyanide (CN_{WAD}-ppm)	5		
	Residence time (min)	60		
	Reagent consumption (g SO_2/g WAD)	2.30		

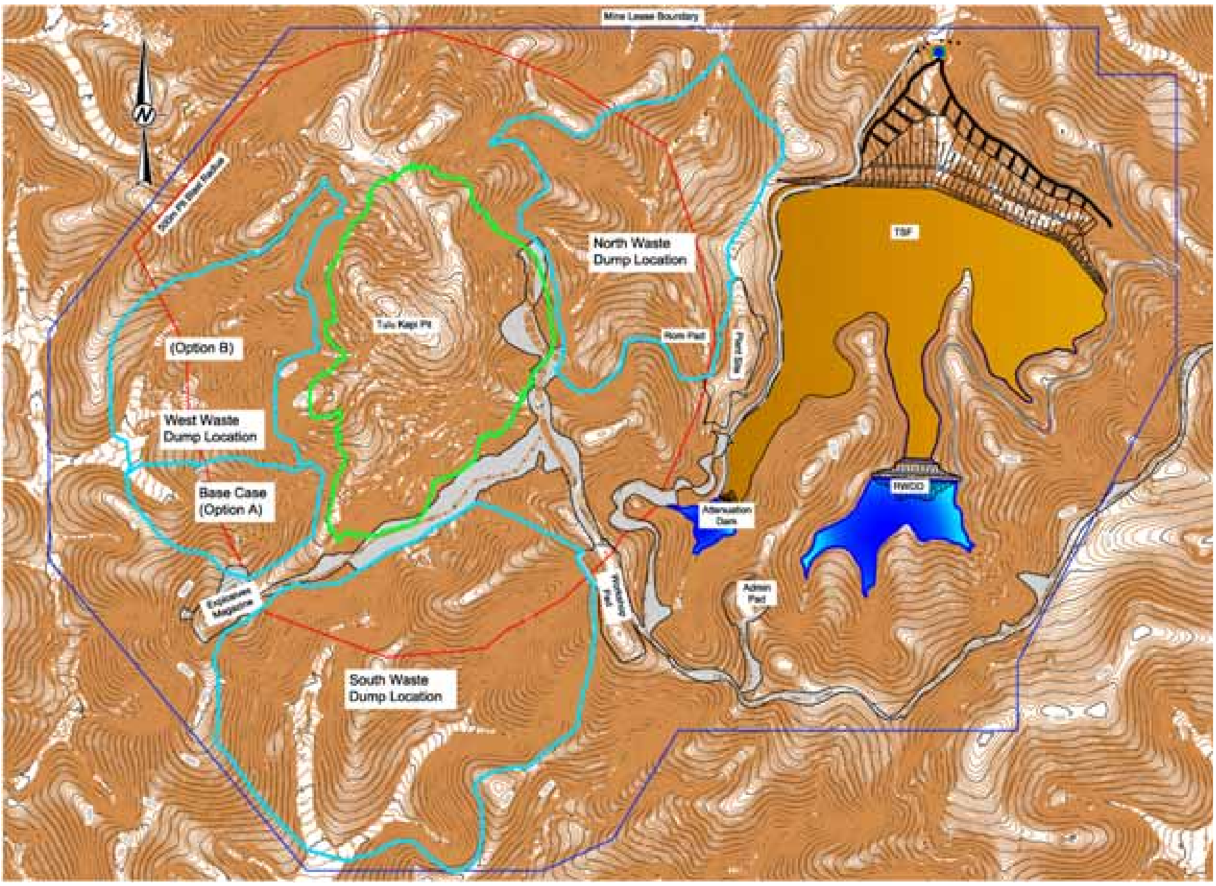
1.7 WASTE MANAGEMENT, TAILINGS DISPOSAL & WATER MANAGEMENT

Mine tailings consist of the residual processed ore that has passed through the processing plant. The tailings, sometimes referred to as mine waste product, are expected to range in particle size from 75-80% passing 75 microns, are transported to the tailings storage facility (TSF) as a slurry. The tailings slurry is deposited into the TSF in a controlled manner to systematically fill the TSF from the starter dam perimeter inward towards the centre. The tailings solids will settle out of the slurry into the TSF and the slurry water component is subsequently pumped to back to the process plant for reuse in the plant and further reused for tailings transport to the TSF.

The TSF has been designed to store tailings generated at a rate of 1.2 million tonnes per annum for the anticipated 13-year life of mine although as described in Section 7.1.2, the TSF, as currently designed, has an ultimate storage capacity to support a 13 year life-of-mine. The TSF dam will consist of compacted soil and mine waste rock that will be constructed in four stages summarized in Table 1-8.

Table 1-8: Summary of 13 Year TSF Storage Capacity

PARAMETER	UNITS	PHASE 1	PHASE 2	PHASE 3	PHASE 4
Life of Mine	yrs	1	2	6	13
Tailings Production Rate	Dry ktpm	100	100	100	100
	Dry ktpa	1 200	1 200	1 200	1 200
Total	Mt	1.2	2.4	7.2	15.4
Volume	10^6 m^3	0.90	1.80	5.41	11.6



Based on the definitive feasibility design of the tailings storage facility as described it is concluded that:

- The preferred site for the development of the Tulu Kapi TSF is on an area immediately adjacent to and to the east of the proposed plant site (Figure 1-4). The site will be developed as an impoundment facility with staged downstream wall lifts to match the anticipated deposition of 1,200ktpa of gold tailings for a period of 6 years, after which the facility will be self-raised as a day wall facility for a further 7 years.
- The geotechnical conditions on the proposed sites of the TSF are considered suitable for the establishment of the facility. Material is expected to be available from the mine for the construction of the containment embankments.
- The site is located in an area of relatively high rainfall which requires that the catchment reporting to the TSF be minimised by the construction of surface water runoff diversion channels and flood attenuation dams.
- The TSF has been classified as a Medium Hazard Facility due to the remoteness of its location, the absence of downstream infrastructure and the proposed method of construction.

- Based on the assessment of the tailings geochemistry there is some uncertainty with respect to the potential for surface and groundwater contamination associated with the TSF. Given this uncertainty a precautionary approach has been taken in the design of the facility. It is intended to contain all surface runoff emanating from the facility and to incorporate into the construction and operation of the facility measures to limit as far as possible the migration of seepage. These measures include:
  - The ripping and re-compaction of the TSF footprint to take advantage of the low permeability soils underlying the facility to slow the rate of seepage to the foundation and encourage the collection of seepage in the toe drainage system.
  - The installation of a series of seepage interception boreholes immediately down grade of the TSF to intercept potentially contaminated ground water flows which would be pumped to a seepage collection sump.
  - The installation of a seepage collection sump and return water pump system at the toe of the TSF to collect drain flows and to accept water pumped from the seepage interception boreholes and return it to the TSF decant pool for use as process water in the plant.

The Mine Waste Dumps (MWDs) were designed to contain waste rock from the open pit operations. . The three mine waste dumps that were designed included the West Waste Dump (WWD), North Waste Dump (NWD) and South Waste dump (SWD) as shown Figure 1-5 below. These two waste dumps provide the required mine waste storage capacity for the current mine plan.

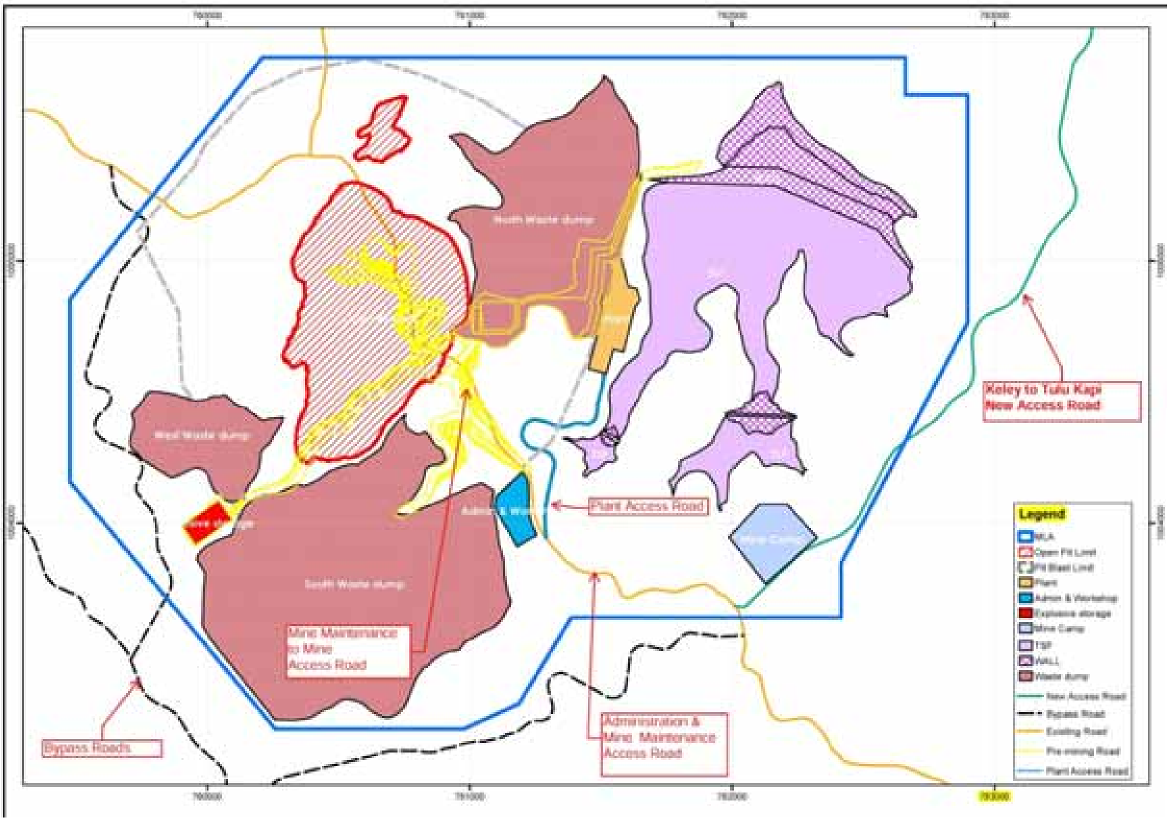


Figure 1-5: Mine Waste Dump locations

1.8 MANPOWER AND TRAINING

The majority of the KEFI workforce will be sourced locally and it is the Company's policy to maintain this practice to the extent possible. It is likely that:

- A large contingent of employees will be sourced from the surrounding village and towns.
- There are few constraints regarding access to a pool of unskilled and semi-skilled labour and the future development of a skills base in the region.

In order to effectively manage the operations at Tulu Kapi, a labour schedule was drawn up to include labour for mining, processing and administrative duties. Figure 1-6: shows the overall management structure for the Tulu Kapi Gold Project.

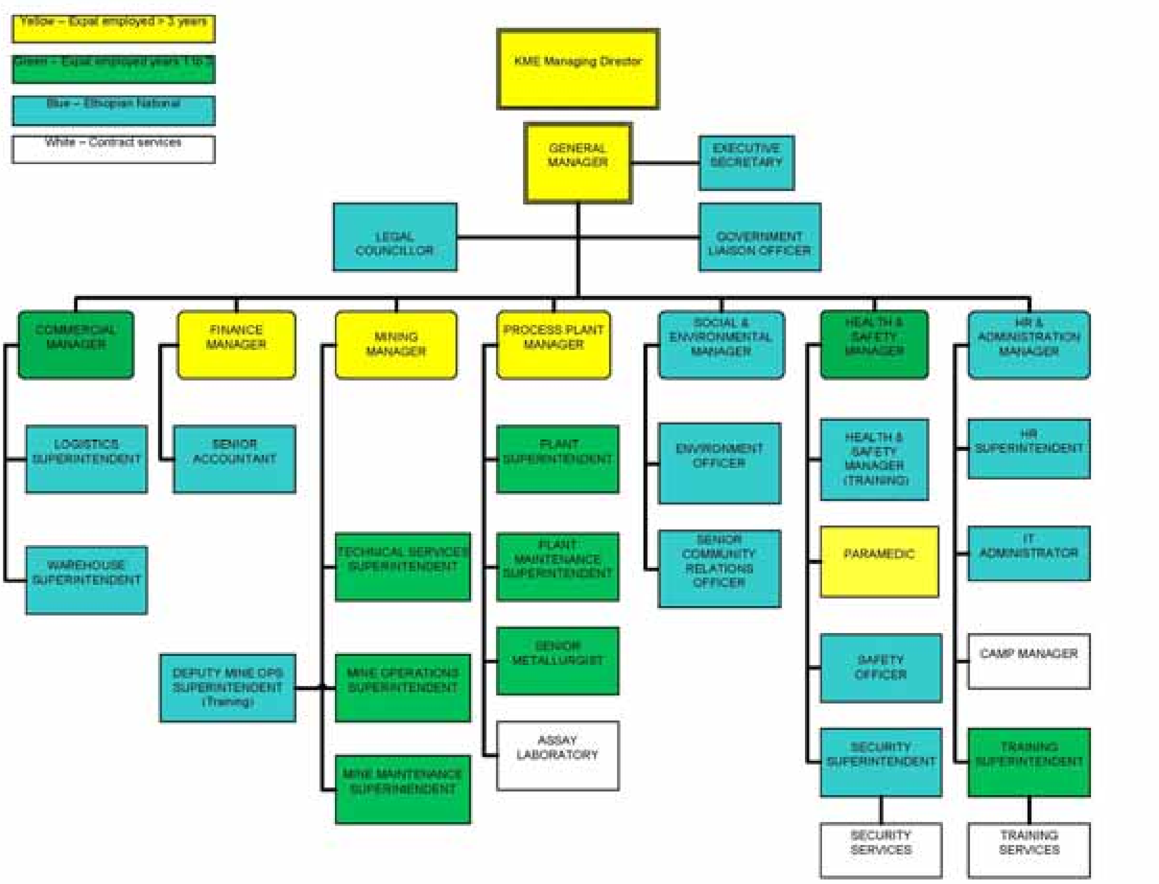


Figure 1-6: Tulu Kapi Overall Management Structure

Operational readiness in terms of human resources requires sufficient and correct recruitment and training:

- The recruitment of the personnel required for the development and operation of the project will be managed by KEFI and is planned to commence in the 4th quarter of 2015.

- KEFI will outsource all of the specialised training requirements to a training organisation. This is to allow for the training requirements to be correctly identified across the organisation and develop suitable career paths for individuals to the mutual benefit of the employee and of Kefi.

1.9 PROJECT AND OFFSITE INFRASTRUCTURE

The proposed infrastructure will support the mining, processing and construction operations. The main site infrastructure required for the development of the project will be the following:

- Mine facilities
- Process plant facilities
- Access roads within the mine licence area
- Power supply
- Power distribution
- Control, instrumentation and communications
- Temporary offices
- Construction camp
- Security
- Firefighting
- Social office infrastructure

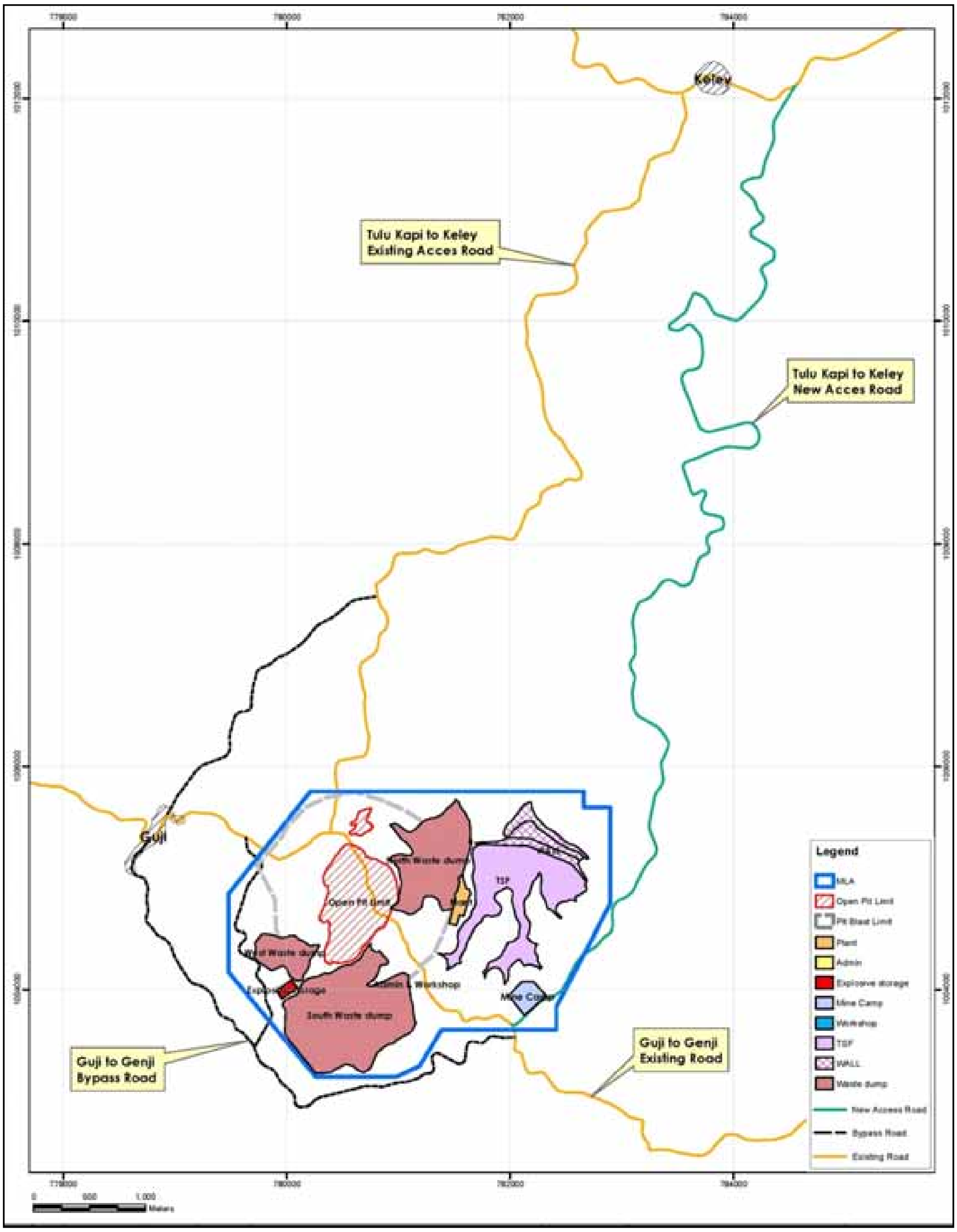


Figure 1-7: Overview of On-Site and Off-Site Infrastructure

1.9.1 Mining Facilities

The following mine facilities have been provided:

- Haul roads
- Mine workshop
- Mining equipment refuelling facility
- Explosives magazine

- Mine administration building (including furnishings)
- Mine clinic
- Main stores/warehouse
- Potable water distribution
- Mine infrastructure water
- Sewage treatment and disposal

1.9.2 Fuel and Lubricant Storage

The fuel storage facility which is situated adjacent to the mine workshop will have sufficient capacity for approximately one month's supply for the mining fleet, estimated to be some 400 metres cube based on an approximate consumption of 15,000 litres per day, along with reserve capacity for emergency pumps and generators.

1.9.3 General Buildings and Facilities at the Mine Infrastructure Terrace

A number of buildings are to be constructed in this area for the Mine services departments:

- Administration and Mining Building
- Mine clinic
- Mine stores/ Warehouse
- Social and Community office

1.9.4 Buildings and Facilities at the Process Plant Area

The processing plant and administration facilities on the process plant terrace shall include the following:

- Plant and administration buildings (including furnishings)
- Process plant access roads
- Process plant site drainage
- Waste management
- Process plant water
- Sewage treatment and disposal
- Transport

The plant workshop consists of two workshop bays, located adjacent to one another. One of the workshop bays will be for mechanical maintenance requirements, and the other bay will be for electrical and instrumentation maintenance requirements.

The workshop contained within the process plant area is for minor maintenance only. The equipment maintenance area within the mining workshop shall be used for more extensive process plant maintenance.

1.9.5 Waste Management

Used oil and disposal services will be provided by the fuel supplier as part of their contract. Construction debris and other inert waste will be placed in designated cells and covered, within the waste rock dump. Solid domestic waste from the mine facilities will be recycled and re-used in an approved manner, where feasible. Other solid waste will be placed in waste receptacles and containers for disposal through waste collection contractors or suitable incinerator.

Biological treatment plant technology will be applied to the treatment and disposal of sewage in the camp. This technology will be selected over others due to its ability to withstand fluctuating loads.

1.9.6 Electrical Power Supply

As part of the development of the Tulu Kapi mining site, KEFI Minerals plans to have electricity supplied from the national Ethiopian grid. The mine will fund the infrastructure costs required to design, supply and construct a new 47 km, 132 kV, 15 MVA power line from Gimbi to the mine site. The power line will, however, be owned and maintained by Ethiopian Electric Power Corporation (EEPCo).

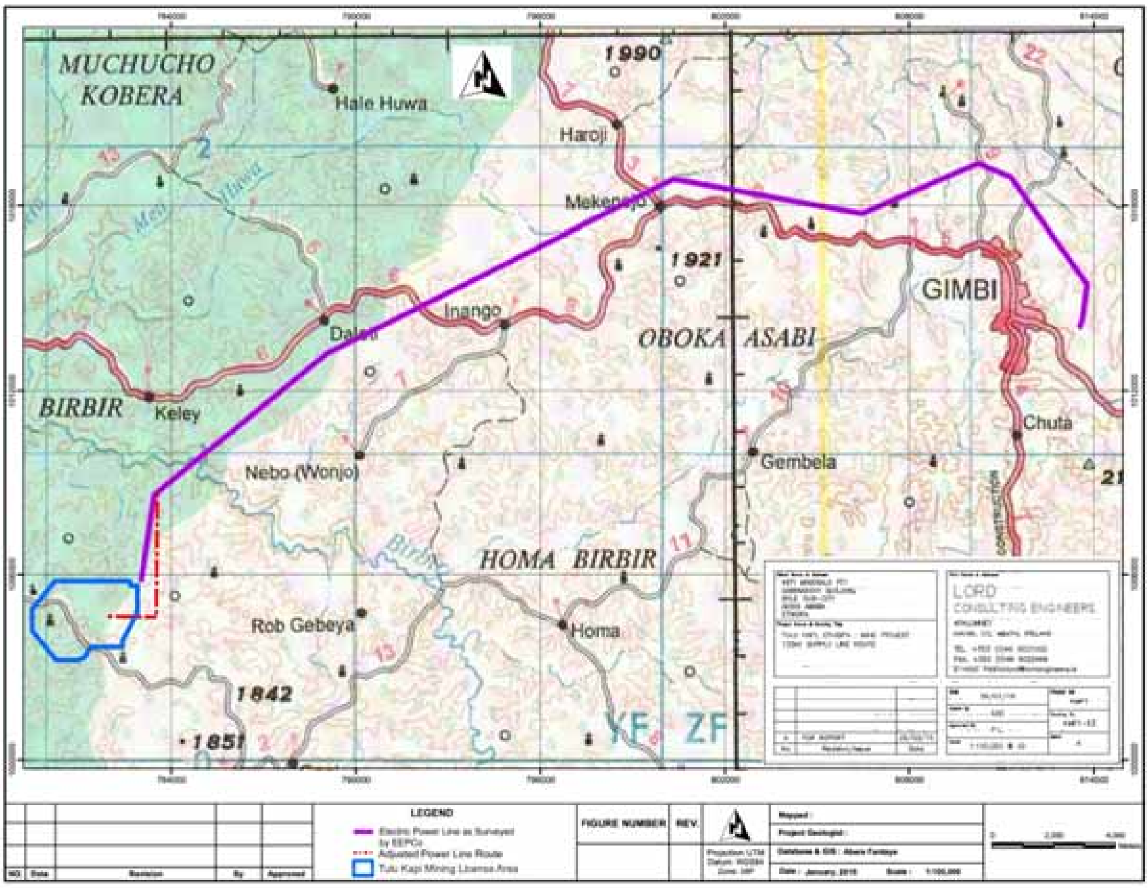


Figure 1-8: Power line route to Tulu Kapi

The incoming grid power at the Tulu Kapi mining site will be at 132 kV while site reticulation will be at 6.6 kV stepping down as required for the mine village, process plant and various other buildings.

The design, supply and construction of the powerline will be a turnkey solution provided by EEPCo. All associated costs relating to the design, supply and construction of the power line will be paid for by the mine while EEPCo will retain ownership of the power line and be responsible for all associated maintenance.

An estimate of the projects power requirements are summarised in Table 1-9 .

Table 1-9: Estimate of Operating Power requirements of the Tulu Kapi Project

Area or Equipment	Installed (kW)	Running (kW)	160 % (kW)	Maximum Start-up (kW)
Tailings return water, Raw water, Seepage Dam, Boreholes and Permanent Camp	285	205		205
Process plant infrastructure	266	190		190
Process plant	3 995	3 389		3 389
Mine infrastructure	589	410		410
Local community	1 000	800		800
SAG Mill (VSD controlled)	1 550	1 205	2 480	1 205
Ball Mill (LRS controlled)	2 800	2 607	4 480	4 480
Total	**9 598**	**8 806**		**10 679**

The maximum power demand for the project during mill start-up conditions is 15MW. This maximum start-up demand is based on the following sequence start:

Process plant running + Process plant infrastructure running + Local community running + Mine infrastructure running + SAG mill running + Ball mill starting up

The SAG mill will be started using a variable speed drive (VSD) and the ball mill will be started using a liquid resistance starter (LRS). The VSD will limit the SAG mill start-up current to 1.6 × full load current (frozen load protection) and the LRS will be designed to limit the ball mill start-up current to 1.6 × full load current.

A 5 MW emergency diesel power plant will provide emergency backup power to critical process equipment and infrastructure in the event of a grid power failure. This will allow critical equipment to remain in operation until it can be safely shut down or until grid power is reinstated.

The protection scheme requirements will be designed with an emphasis on stability and reliability of power supply.

1.9.7 Communications

The communication systems required to suit the staff and the amount of data transmitted around the mine site and externally will comprise:

- Process Control System (PCS) to monitor and control the process plant as well as to establish the infrastructure for the office LAN and telephone and radio communication systems.
- SCADA and programmable logic controller (PLC) system (using fibre optics as the backbone),
- A local area network (LAN) to facilitate the connection of computers across the site
- External communication systems (satellite, internet, e-mail, telephone and radio)

1.9.8 Security

The process plant, village and explosives storage area will each be surrounded by a security fence to prevent unauthorised entry. Restricted access to these areas will be by means of a main access gate manned 24 hours per day by security guards. Provision for additional access emergency gates will be provided. These shall, however, be kept locked and strict access control procedures will be in place to control their use.

Additional fencing will be provided for safety and security within the following areas of the process plant area, such as:

- Power plant (medium security fence)
- Fuel storage (medium security fence)
- Gold room area (high security fence)
- Transformers (medium security fence)
- Substations (medium security fence)

Gold will be transported by means of a secure vehicle to the helipad, with suitable security arrangements in place.

Furthermore, the plant will be fitted with suitable CCTV cameras installed at strategic locations to provide monitored surveillance. Static and pan tilt and zoom (PTZ) Camera will allow for adequate security monitoring of the plant and gold room. Views from the cameras will be fed to a central security control room situated in the security/access room of the plant and gold room security room.

1.9.9 Roads Outside the Mine Licence Area

Although there is an existing road which connects the village of Kelley to the project area, to minimise impact on the local community the Tulu Kapi Gold Project will require, during the project implementation period, the construction of two major roads that lie outside the mine license area, specifically:

- Kelley to Tulu Kapi access road. Total length of 14.97 km (~9.5 km lies outside the mine license area).
- Southern Bypass road. Total length of 4.5 km.

1.9.10 Access Roads within the Mine Licence Area

The Tulu Kapi Gold Project includes the construction of roads that lie inside the mine licence area, specifically:

- Kelley access road to the administration and mine maintenance facility.
- Administration and mine maintenance facility to Process plant.
- Mine maintenance facility to the pit road.
- Mine haul roads from the pit to the ROM stockpile, Mine Waste Dumps (MWD's) and Tailings Storage Facility.

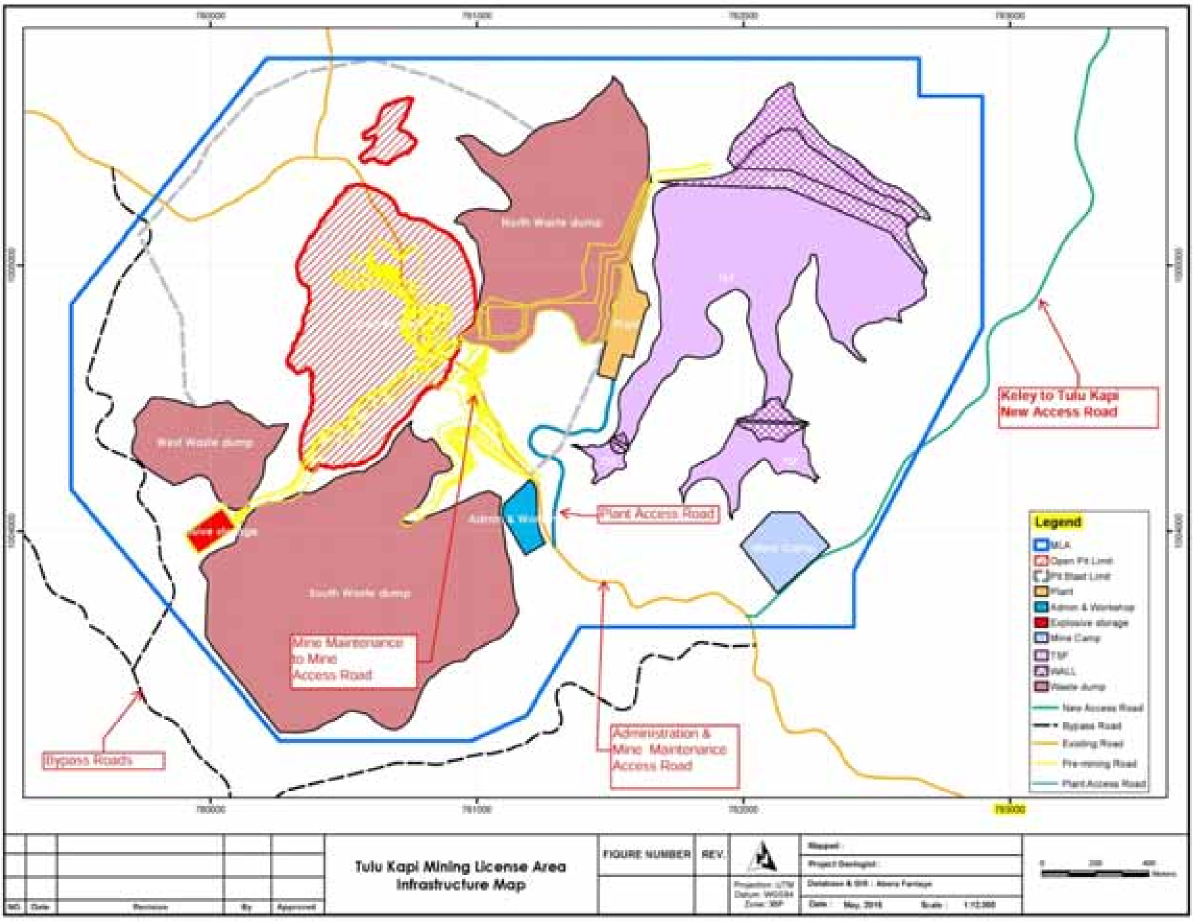


Figure 1-9: Roads inside of the mine licence area

1.9.11 Mine Accommodation Camp

A mine accommodation camp will be constructed to house senior and junior staff members, comprising both Ethiopian nationals and expatriates. The accommodation capacity of the village will be approximately 232 residents and have an operational life span of at least 10 years.

The design and construction of the village will involve the expertise of an Addis Ababa based project management company. Staff accommodation will consist of Concrete Hollow Block (HCB) buildings with Galvanized Iron Steel roofing. Various categories of accommodation will be provided.

1.9.12 Logistics and Transport

The following combination of global shipping methods into the project site will be applied:

- Method 1: Containerised cargo
- Method 2: Break-bulk cargo or charter vessels

The recommended route to the Tulu Kapi site will be as follows:

- First leg: Durban to the Port of Djibouti by sea
- Second leg: Port of Djibouti to Addis Ababa by road
- Third leg: Addis Ababa to Tulu Kapi site by road

1.10 ENVIRONMENTAL AND SOCIAL

During 2011 and 2012 Golder Associates was appointed to conduct a review of the 2010/2011 ESIA against World Bank and IFC Standards. Following the review and subsequent gap analysis, Golder was appointed to update the ESIA to World Bank and IFC Standards for submission to international lenders.

In 2014, Golder Associates was appointed to prepare an Addendum to the 2012 ESIA for submission to the Federal Ministry of Mines and international lenders. In 2015, Golder Associates was again appointed to integrate the Addendum Report into the 2012 ESIA Report as part of the Definitive Feasibility Study for submission to international lenders.

1.10.1 Assessment of Potential Impacts

Social and environmental impacts assessed are presented below:

1.10.1.1 Air Quality

Potential impacts during construction and operations are anticipated to be the degeneration of the ambient air quality due to increased dust (PM2.5, PM10 and TSP) levels from mining activities.

1.10.1.2 Acid Mine Drainage / Geochemistry

In the short to medium term, it is anticipated that Acid Mine Drainage is not likely to be an issue due to the low degree of sulphide reactivity despite the relatively high sulphide content (>1%) and excess Neutralising Potential. However, the projections indicate that the carbonates will be depleted much earlier than sulphides, and therefore the low grade ore and albitised syenite waste rock materials could be Potentially Acid Generating in the long term.

1.10.1.3 Cultural Heritage

Impacts identified relate mostly to impacts to indigenous belief systems, structures (e.g. trees) and sites of cultural significance. During resettlement or relocation, decreased access to traditional environmental resources, dissociation from current social structures, and familial separation could occur.

1.10.1.4 Terrestrial Ecology

The main construction phase and operational phase impacts anticipated relate to habitat destruction, potential disturbance of ecological systems in adjacent areas, impacts due operational issues (e.g. spillages) and potential increases in presence of exotic species.

1.10.1.5 Aquatic Ecology and Wetlands

The main impacts anticipated are due to emergency incidents (e.g. spills) resulting in downstream impacts, as well as loss of in-stream habitat and biodiversity due to positioning of mining infrastructure (e.g. TSF and Waste Rock Dumps (WRDs)).

1.10.1.6 Geohydrology

Effective management of groundwater is required to ensure safe and cost-effective mining operations. To achieve this, dewatering and depressurisation is likely to be undertaken at Tulu Kapi during the life of the mine to ensure dry mining conditions and pit wall/floor stability.

1.10.1.7 Noise and Vibration

The main impacts anticipated are during the operational phase by the noise emissions from mining activities. The noise impact on the environment and the people residing in the vicinity of the proposed mine will have to be proactively managed during the construction and operational phases. Vibration impacts associated with blasting at the north pit will need to be closely monitored.

1.10.1.8 Soils

The main construction phase and operational phase impacts anticipated relate to disturbance of soils and loss of arable land as well as an increased risk of erosion.

1.10.1.9 Socio-Economic Impact

Potential socio-economic impacts might include population influx, physical and economic displacement of project affected households; increased pressure on natural resources and ecosystem services, perceived increases in employment opportunities, skills development and skills transfer, economic diversification, and cost of living, improvements in local and national economy, increased vulnerability of women, youth and elderly, damage to cultural heritage and archaeological resources through land transformation activities, and safety and security risks.

1.10.1.10 Stakeholder Engagement

Primary concerns of community stakeholders included respect is required towards the community and preservation of community participation during project implementation, promotion of economic diversification is required, adequate and timely compensation for crop/livelihood loss is needed, socio-economically appropriate resettlement of displaced households is crucial, availability of increased employment opportunities and skills training to local residents, with particular attention to gender equity from the mine, infrastructure improvements, particularly health services, all-weather roads, clean water, school facilities, and electrical supply.

1.10.1.11 Surface Water

Impacts anticipated are increased erosion and runoff volumes, stream crossings altering banks of watercourses, potential spillages from mining operations, catchment reduction due to placement of mining infrastructure (e.g. TSF and WRDs), increased salinity and metal leaching, and the open voids post closure.

1.10.1.12 Waste Management

Improper management of general, mining and hazardous waste may result in adverse environmental impacts.

1.10.1.13 Ecosystem Services

The proposed Project will have an adverse effect on a number of priority ecosystem services on which there is currently a high dependence, particularly for downstream beneficiaries, due to loss of habitat and biodiversity, and changes in condition of remaining habitat.

1.10.2 Mitigation/Management Measures

Table 1-10 presents a summary of Kefi's social and environmental commitments as discussed in detail in the ESIA. This is a summary of the social and environmental commitments based on the project design measures, mitigation actions, monitoring and follow-up, consultation, and the environmental management system (EMS).

Table 1-10: Summary of Social and Environmental Management Measures to be Implemented at Tulu Kapi

Management Plan	Measures to be Implemented
Air Quality Management Plan	Dust mitigation and monitoring will be done to prevent the generation of atmospheric dust that would constitute a health hazard or nuisance to people living nearby or those working on-site. The Air Quality Management Plan includes control measures for minimizing dust produced on access/haul roads, from the waste rock dumps and overburden stockpiles, during blasting operations, from construction equipment, and material handling sources. In addition, all stationary and mobile equipment will be kept in good working order to minimize emissions.
Noise and Vibration Management Plan	Kefi will implement a number of measures according to the IFC Environmental, Health and Safety (EHS) Guidelines, including: the inspection and maintenance of plant equipment and machinery to ensure that they are properly muffled; use electrical (rather than pneumatic or mechanical) equipment as much as possible; carry out noise monitoring at sensitive receptor locations and site boundaries; will use silencers, acoustic barriers, etc., if noise levels exceed limit levels. Blasts will be designed so that ground vibration levels not exceeding 10mm/s at houses and the air over pressure level of 134 dB and 120 dB in the vicinity of schools and/or churches are adhered to.
Water Management Plan	Kefi will develop and implement a Water Resources Management Plan that addresses water withdrawal and/or retainment and utilization, and discharges. The Plan incorporates measures to ensure that: • Water extraction is conducted in agreement with the established environmental protection criteria; • There is an adequate supply of suitable quality water for domestic and operation purposes; • Mining and industrial water is managed in such a way that effluents are not discharged to the environment, including the provision of engineered barriers for facilities that might be acid generating (e.g. WRDs, TSF, ROM Pad etc.); • Domestic water effluents are treated appropriately prior to release; and • The physical stability of the Tailings Storage Facility, the storm-water Management facility and the Raw Water Diversion Dam is not compromised during the mining lifecycle.
Waste Management Plan	Kefi will be responsible for the development of a detailed waste management plan which will keep waste to a minimum and emphasize the waste management hierarchy of reduce, reuse, recover, treat, or landfill (for non-hazardous materials). All waste will be stored, treated, disposed of and transported in accordance with the provisions of the IFC EHS guidelines. Employees will be provided with training and encouraged to implement waste management practices.
Soils and Land Management Plan	In order to minimize erosion and where feasible each section of work will be progressively mulched and revegetated as it is completed; vehicles will be confined to well-defined roads; adequate road drainage will be provided (based on road width, surface material, compaction, etc.), and the site will be stabilized and erosion controls maintained so that they remain effective during any pause in construction. Upon completion of the work, the effectiveness of soil stabilization measures will be evaluated and if necessary, stabilization measures will be taken to protect infrastructure and avoid

Management Plan	Measures to be Implemented
	degradation of the environment. Fuel and oil tanks and dispensing areas will be isolated to capture any spills. Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bio-remediation, in accordance with procedures to be developed.
Flora and Fauna Management	Disturbance to terrestrial ecology be kept to a minimum by demarcating the construction areas and restricting construction to these areas only. In addition, replanting of plants and trees of conservation importance, where they were removed, during the construction and operation phases the number of these species removed can be recorded so that the same number can be replanted during rehabilitation or through Kefi's established community reforestation programme. Kefi shall investigate the feasibility of establishing environmental preservation areas. Such areas would have a beneficial contribution to the mitigation measures proposed for the Tulu Kapi Gold mine, specifically biodiversity mitigation measures.
Social Management Plan	Kefi will maintain ongoing liaison with communities through the implementation of their Stakeholder Engagement Plan throughout the project lifecycle. Kefi will develop, disclose, adopt and implement the following management plans to address the impacts associated with influx and social services and infrastructure: • Influx Management Plan; • Community Development Plan (CDP); • Contractor Management Plan; • Recruitment, Training and Local Employment Plan; • Community Health Management Plan; and • Environmental and Social Awareness Plan; The implementation of the RAP and Livelihoods Restoration Program will further ensure that impacts to livelihoods, access to project restricted areas, etc. is managed efficiently.
Cultural and Heritage Resources	There is potential to unearth artefacts in the Project area during the construction phase of the Project. A Chance Find Procedure will be implemented to address these unplanned discoveries. In case of artefact discovery, work will be stopped in that area and an archaeologist will be notified.
Emergency Preparedness and Response Plan	Kefi will develop and implement a detailed Emergency Preparedness and Response Plan. The Plan shall: • Provide a system to manage emergencies on-site; • Provide for regular review and update of emergency procedures; • Facilitate on-site emergency response and provide appropriate assistance to responding emergency services; • Communicate vital information to all relevant persons as soon as possible; • Control or limit the effect of an emergency; • Minimise adverse effects on people, property and the environment; • Continually maintain a high level of awareness and preparedness; and • Responsibilities will be assigned to the personnel in accordance with the Site Emergency Plan.
Closure Plan	Kefi will develop and implement a detailed Closure Plan, following the construction phase of the Project. Adequate financial provisions will be made in consultation with the Ethiopian government to ensure that adequate finances are available for closure. The

Management Plan	Measures to be Implemented
	closure cost is subject to detailed design updates and the closure planning process throughout the life of the mine, as it will be updated to ensure alignment with the rehabilitation measures required. The closure plan will be reviewed and updated at minimum every two years during the life of the mine, and annually during the last 5 years of operation. The primary objectives of the Closure Plan will be: • The physical and geochemical stabilization of all Project components; • The establishment of final landforms; • The rehabilitation of disturbed areas and habitat using local, native species; and • The protection of the public, domestic animals and wildlife from injuries that could be caused by access to closed facilities.

1.11 IMPLEMENTATION

The successful execution of the Project requires a carefully considered implementation strategy. This includes the development of a competent owner's team, together with the appointment of a well-respected EPCM contractor.

The execution philosophy is described by SENET and should be interpreted as being valid for any reputable EPCM Contractor.

1.11.1 KEFI Implementation Strategy

The following key activities are included in KEFI's implementation strategy:

- Project management
- Owners team
- EPCM contractor
- Contractor liaison
- Cost control
- Quality control

These activities are shown in Figure 1-10.

Figure 1-10: Tulu Kapi Indicative Schedule

1.12 CAPITAL COSTS

The study will be used to determine the commercial and technical feasibility of the Tulu Kapi Gold Project as an owner-operated open-pit mine, with a conventional grinding, CIL plant designed to process 1.2 Mtpa. In order to carry out the necessary analysis, sufficient design, scheduling and equipment costing has been carried out to prepare capital cost estimates to an accuracy of + 15 % to -10 %.

1.12.1 Capital Cost Estimate

The total estimated cost of bringing the project into production is **US$ 175.6M,** which is inclusive of contingency.

1.12.2 Mining Capital Estimate

Mining capital costs were estimated from equipment vendor quotations. Requests for budget quotation were issued to recognised vendors with in-country representation.

1.12.2.1 Mining Fleet Capital Costs

The capital estimate allows for the majority of the earthmoving equipment to be purchased from Komatsu with blast hole drills to be sourced from Atlas Copco. Minor equipment were source from a variety of locations throughout the world. A summary of the capital equipment cost build up is given in is given in Table 1-11.

Table 1-11: Mining Capital Cost Estimate Summary

Description	Initial Capital Cost (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl. Cont.) (US$,000)	Sustaining Capital Cost (US$,000)	Total Capital Cost (US$,000)
Mining Equipment/Fleet					
Equipment (incl. delivery)	19,058	2,118	21,175	26,403	47,218
Capital Development					
Explosives Magazine Terrace	623	0	623	0	623
Computers and Software/Software Licensing	135	0	135	0	135
Engineering/Geology Equipment	159	0	159	0	159
Shop Tools	200	0	200	0	200
Mobilisation of Explosives Contractor	250	0	250	0	250
Initial Spare Parts	1,677	0	1,677	559	2,236
Sub Total Capital Development	**3,044**	**2,118**	**3,044**	**559**	**3,603**
Pre-strip	14,027	1,559	15,586	0	15,586
Sub Total Pre-strip	14,027	1,559	15,586	0	15,586
Total Mining	**36,129**	**3,677**	**39,805**	**26,602**	**66,407**

1.12.2.2 Pre-strip and Mine Pre-production

Table 1-12: Pre-strip & Mine Pre-Production

	Installed Costs (US$,000)
Plant Operating Cost	
Primary Fleet	5,544
Ancillary Fleet	982
Minor Equipment	191
Light vehicles	355
Total Plant Operating Cost	**7,073**
Materials	
Drilling Consumables	227
Explosives	1216
Road base	107
Total Materials Cost	**1550**
Mining Management	487
Mine Technical Service Department	748
Operators	1,017
Mine Maintenance	962
Total Labour Cost	**3,214**
Mining Overheads	
Explosive into the hole delivery service	1,005
Grade Control (assay and consumables)	194
Tech support and training	159
General mining expenses	159
Mine Workshop	108
Total Mining Overheads	**1,626**
Contractor Costs	
Clearing and grubbing	628
Topsoil removal	1,257
Waste dump under drainage	238
Total Contractor Costs	**2,124**
Total Pre-strip & Mine Pre-production	**15,586**

1.12.3 Process Plant Capital Cost Estimate

The process plant costs were split into Phase 1 and Phase 2 and are defined as follows:

- Phase 1 - costing of process plant to process ROM ore from Years 1 – 3
- Phase 2 – addition of secondary crushing and screening circuits to accommodate the change in ore type fed to the process plant from Year 4 onwards

1.12.4 Process Plant and Infrastructure Capital Cost Summary – Phase 1

A summary of the process plant capital costs for Phase 1 is summarised in Table 1-13.

Table 1-13: Process Plant Initial Capital Cost Summary

Description	Initial Capital Cost (US$)	Contingency (%)	Initial Capital Cost (Incl. Contingency) (US$)
Process Plant Direct Costs			
Earthworks	4,277,906	20%	5,133,487
Civils	5,318,313	18%	6,275,609
Plant Infrastructure - Buildings	1,051,362	8%	1,135,471
Plant Infrastructure - Civils	793,773	18%	936,652
Structural Steel	1,731,698	10%	1,904,868
Platework (Tanks)	1,641,413	10%	1,805,554
Machinery & Equipment	10,542,769	5%	11,069,907
Piping	1,163,933	20%	1,396,719
Valves	277,953	20%	333,544
Electricals	2,400,174	10%	2,640,191
Instrumentation	1,266,972	8%	1,368,330
Communication and Security	235,670	8%	254,524
Vendor Services	327,114	10%	359,825
Transport	4,624,940	10%	5,087,434
Spares Commissioning	105,933	5%	111,230
Plant First Fills	694,257	5%	728,970
Construction Equipment	3,533,899	10%	3,887,289
SMPP - Construction Labour	2,910,248	10%	3,201,273
Electrical and Instrumentation Installation	1,375,591	10%	1,513,150
Process Pant Direct CAPEX Subtotal	**44,273,918**		**49,144,027**
Process Plant Indirect Costs			
Emergency Power Plant	350,505	7%	375,041
Construction Camp	2,949,275	10%	3,244,203
Plant Overhead Lines	69,581	15%	80,018
Vehicles	800,287	5%	840,301
Mobile Equipment	419,200	5%	440,160
Process Plant Indirect CAPEX Subtotal	**4,588,849**		**4,979,723**
Site Infrastructure			
Site Infrastructure - ALL Costs	9,648,830	12%	11,183,991
Mining Infrastructure CAPEX Subtotal	**9,648,830**		**11,183,991**
Other Costs			
Spares Operational	638,115	5%	670,021
Spares Insurance	701,562	5%	736,640
Other CAPEX Subtotal	**1,339,677**		**1,406,661**
EPCM and Insurances			
EPCM	9,094,247	10%	10,104,719
Insurances	589,346	10%	648,281
EPCM and Insurance CAPEX Subtotal	**9,683,593**		**10,753,000**
Total Process Plant and Infrastructure CAPEX - Phase 1	**69,534,867**		**77,467,402**

1.12.5 Process Plant and Infrastructure Capital Cost Summary – Phase 2

A summary of the process plant CAPEX for Phase 2 is summarised in Table 1-14.

Table 1-14: Process Plant Sustaining Capital Cost Summary

Process Plant CAPEX Item	Sustaining Capital Cost (US$)	Contingency (%)	Sustaining Capital Cost (Incl. Contingency) (US$)
Process Plant Direct Costs			
Civils	120,171	18%	141,801
Structural Steel	368,715	10%	405,586
Platework (Tanks)	134,138	10%	147,552
Machinery & Equipment	514,447	5%	540,170
Vendor Services	45,113	10%	49,624
Transport	466,895	10%	513,585
Spares Commissioning	385	5%	404
SMPP Construction Labour	264,402	10%	290,842
Process Pant Direct CAPEX Subtotal	**1,914,266**		**2,089,564**
Other Costs			
Insurance	20,023	10%	22,026
Spares Operational	47,073	5%	49,427
Spares Insurance	40,988	5%	43,038
Other CAPEX Subtotal	**108,085**		**114,490**
Total Process Plant and Infrastructure CAPEX - Phase 2	**2,022,351**		**2,204,055**

The basis used to develop the capital cost for Phase 2 was the same as that used for Phase 1. The EPCM costs for Phase 2 have been excluded from this study as this was considered deferred capital.

1.12.6 Tailings Storage Facility

1.12.6.1 TSF Capital Expenditure

Summaries of the estimates of capital costs for the phased development of the TSF over the life of mine of 13 years are presented in Table 1-15 below is inclusive of provisions for Contractor's Preliminary and General Costs at 25% of the value of the measured works. It is estimated that the cost of establishing the Tulu Kapi TSF would be $8.186 million. The on-going development of the TSF would require the expenditure of $15.703 million over the remaining project life.

Table 1-15: TSF Capital Expenditure by Phase

Description	Initial Capital Cost (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl Contingency) (US$,000)	Sustaining Capital Cost (US$,000)	Total Capital Cost (US$,000)
Phase 1A	6,265	626	6,891	0	6,891
Phase 1B	999	99	1,098	1,098	2,196
Phase 2	0	0	0	3,548	3,548
Phase 3	0	0	0	10,665	10,665
Phase 4	0	0	0	392	392
Design & Engineering	197	0	197	0	197
Totals	**7,461**	**725**	**8,186**	**15,703**	**23,889**

1.12.6.2 TSF Pumping and Piping

The design of the return water and pumping systems is described in Annexure 7-3 contains the design and cost estimate for the TSF return water management at a cost of $1.239 million.

1.12.7 Raw Water Storage Facility and Associated Pumping and Piping

Total cost of the raw water diversion dam, infrastructure and spillway is $3.827 million as presented in Table 1-16.

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Table 1-16: Raw Water Delivery System

Description	Initial Capital Costs (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl Contingency) (US$,000)
Raw Water Dam Construction	2,343	234	2,577
Associated Infrastructure & Engineering	450	50	500
Spillway	675	75	750
Total	**3,468**	**359**	**3,827**

1.12.8 Off-site Infrastructure Cost

Off-site infrastructure is those projects that are outside the general location of minesite operations, this includes the mine village, the power line and infrastructure connection to the national power grid and the access road from the highway to the minesite. Total capital costs are estimated at $22.801 million.

Table 1-17: Off-site Infrastructure

Description	Initial Capital Cost (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl Contingency) (US$,000)
Infrastructure Costs			
Overhead Power lines	10,528	1,053	11,581
Village (incl. consultants fees)	3,200	320	3,520
Access & Bypass Roads	7,000	700	7,700
Infrastructure -Total	**20,728**	**2,073**	**22,801**

The total cost of the 47km overhead power line connecting the mine site to the Ethiopian power grid is estimated to be $11.581 million. This includes supply, construction, design and supervision along with environmental costs.

The 232 man KEFI Village includes the cost of construction and associated infrastructure including the furniture and fittings. Total cost estimate is $3.520 million.

The 14kms of roads 9.5km site access and 4.5 of concession bypass roads. The estimated cost for roads totals $7.700 million.

1.12.9 Owner's Costs and Working Capital

Table 1-18: Pre-Production and Working Capital Costs

Description	Installed Costs (US$,000)
Owners Costs	
Construction Management Labour	1,040
G&A Labour	1,111
Mining Labour & Maintenance	831
Processing Labour & Maintenance	606
Assay Laboratory (Mining + Process)	1,047
Camp Food and Catering Costs	77
Maintenance	67
Offsite Offices & Travel	721
Supplies & Spare Parts	540
Other Admin Costs	314
Training	2,500
Sub Total Owners Costs	**8,854**
Working Capital	**5,449**
Total	**14,303**

1.12.10 Resettlement

The development of the Tulu Kapi Gold Mine will require relocation of some local residents. To provide for crop compensation, property compensation, relocation, infrastructure and livelihood re-establishment $7.5 million has been allocated. An additional $1.245 million has been provided to assist the community restoring their livelihoods after resettlement.

1.12.11 Environmental Management

An allocation of $0.525 million to develop our Environmental Management capacity by the continuing development of management plans prior to production.

1.12.12 Closure Costs

The closure plan has been broken into four cost elements, TSF closure, waste dump, general site clean-up and a provision for equipment and suppliers to assist in the overall closure. The total provision is $11.863m.

1.12.13 EPCM

The EPCM estimate was established on a detailed man-hour schedule, per discipline, based on the engineering, procurement, construction and project management work anticipated to reasonably complete the SENET controlled scope of works within the project.

1.12.14 Insurance

Insurance has been estimated at 1.0 % of the plant and infrastructure capital costs.

1.13 OPERATING COST ESTIMATES

The purpose of the operating cost estimate (OPEX) is to provide costs that will be utilised to assess the economics of the Tulu Kapi Project. The level of accuracy of the OPEX is -10% +15% of the overall project costs as of Q1 2015 and does not include any escalation factors.

1.13.1 Taxes and duties

All operating cost estimates compiled for this DFS have been done so on the basis that the project is tax and duty exempt.

1.13.2 Mining Operating Costs

The total mine operating costs, based on an owner operated scenario, was estimated to be $359 million for the life of mine. Based on a total material movement of 134 million tonnes the unit operating cost was estimated to be $2.68 per tonne.

1.13.2.1 Mining Plant Operating Costs

The total mining plant operating costs include: primary fleet being the predominant cost driver, fuel, lubricants, spares, tyres, ground engaging tools and general maintenance. The final mining plant operating cost was estimated to be $1.43 per tonne.

1.13.2.2 Mining Materials Cost

Final mining materials costs, including: explosives, consumables and road bases, were estimated at $0.52 per tonne mined.

1.13.2.3 Mining Labour Cost

Total mining labour costs, based on manpower requirements and industry bench mark derived salaries, is $0.49 per tonne mined.

1.13.2.4 Mining Overheads

Mining overheads allow for fixed costs associated with the project and costs not covered elsewhere and have been estimated at $0.20 per tonne mined.

Contractor costs, pre-production, have been estimated at $0.04 per tonne mined.

1.13.3 Processing Plant and Assay Laboratory Costs

Operating costs for the plant, by ore type, are outlined in Table 1-19

Table 1-19: OPEX by Ore Type

Opex Item	Unit	Ore Type		
		Oxide	Shallow Fresh	Deep Fresh
Consumables	US$/tore	6.88	4.49	6.38
Power	US$/tore	0.60	0.64	0.73
Labour	US$/tore	1.74	1.74	1.74
Maintenance, Parts & Supplies	US$/tore	0.63	0.63	0.63
Total Process Plant Opex	**US$/tore**	**9.86**	**7.50**	**9.48**
Assay (Process & Mining)	US$/tore	0.12	0.12	0.12
Total Process Plant Opex +Assay	**US$/tore**	**9.98**	**7.63**	**9.60**

1.13.4 General and Administration Operating Costs

G&A costs were estimated to be US$5.39/t for the LOM. G&A spend halves to US$3.6 million per annum when mining operations cease and the low grade stockpiles feed the mill in years 11 to 13.

Table 1-20: Summary of G&A Cost

Description	Unit	Cost ($US,000)
G&A Salaries	US$/a	2,487
Camp Food and Catering	US$/a	746
Maintenance	US$/a	809
Off-Site Office - Addis Ababa Office	US$/a	360
Supplies and Spare Parts	US$/a	69
Security Contractor	US$/a	378
Other Administration Costs	**US$/a**	**2,288**
Misc. Administration Costs	US$/a	543
Environmental & Social G&A	US$/a	240
Ongoing Closure & Rehab	US$/a	125
Access & Bypass Road Maintenance	US$/a	180
Corporate Management Fee	US$/a	1,200
Total G&A	**US$/a**	**7,137**
Total G&A	**US$/t**	**5.39**

1.13.4.1 Environmental and Social Infrastructure Programme

Environmental costs relate to various areas shown in the table below with the following annual allowances (all contributions will be made on an annual basis for the 10 years + 3 Years at 50%):

Table 1-21: Environmental and Social G&A

Description	Cost
Environmental & Social G&A	**239,750**
Consumables	11,250
Waste Management	10,000
Environment Training	6,000
Equipment Maintenance	5,000
Consultants	50,000
Laboratory & Monitoring	25,000
Equipment	25,000
Community Development Fund	100,000
Social Training	7,500
Ongoing Closure & Rehab	**125,000**
Access & Bypass Road Maintenance	**180,000**
Corporate Management Fee	**1,200,000**
TOTAL	**1,744,750**

A provision has been made totalling $100,000 to provide for Consultants, Laboratory Analysis and Equipment as required to support our Environment and Social monitoring plans and activities. In addition $125,000 for ongoing site rehab and closure activities beyond those carried out by the mine and process plant.

The commitment to the community in our Mining License Application was 2,000,000 Birr annually for Community Development, this equates to $100,000 a year.

1.13.4.2 Corporate Management Fee

A provision has been made for management and services provided to KEFI Minerals Ethiopia by KEFI Minerals plc. The provision is $1,200,000 per year for the first 10 years of operation dropping to $600,000 at the cessation of mining until processing is completed in year 13.

1.14 RIGHTS, OWNERSHIP AND LEGAL MATTERS

The Tulu Kapi licence is currently held as a mining licence. An application to convert it to a Large-Scale Mining Licence was made in October 2014 and the former exploration licence (MOM\EL\127-128/97) that encompassed the Tulu Kapi project was effectively replaced by a Mining Licence (MOM\LSML\81\2015) on 13 April 2015.

The mining licence location area and proposed project layout, which covers 7 km^2. Under Ethiopian law, the mining licence grants the licence holder the right to build and operate a mine. When the Mining Licence was issued, a Mining Agreement with the Government of Ethiopia, which sets the fiscal regime, taxation and royalties as they affect the operation of the mine, was also signed. The Licence and Mineral Agreement were signed by KEFI and the Company's wholly owned subsidiary on 13 April 2015, and are valid for 20 years. The Mining Licence can be renewed, with each renewal subject to a maximum period of 10 years.

The signed mining licence and mineral agreement are valid for 20 years from the date of signing and can be renewed, with each renewal subject to a maximum period of 10 years. Surface land rights remain the property of the State. These include rights to farmland cultivated within and surrounding the Tulu Kapi project. Local residents have tenure to land from the State. Ethiopian law makes provision for the repossession of land that the government deems necessary for mining or other activities beneficial to the State.

The primary legislation governing exploration and mining operations in Ethiopia is contained in the following instruments:

- Mining Proclamation No. 678/2010 (Mining Proclamation) and its amendment of 816/2013
- Mining Operations Council of Ministers Regulations No. 22/1998 (as amended) (Mining Regulations)
- Mining Income Tax Proclamation No. 53/1993 and its amendment of 802/2013 (Mining Income Tax Proclamation)

1.15 FINANCIAL ANALYSIS

A financial analysis of the Tulu Kapi project has been conducted using the discounted cash flow method, by taking into account milled tonnages and grades for the ore and the associated recoveries, gold price, operating cost, bullion transport and refining charges, royalties and capital expenditure (initial and sustaining). The project has been evaluated as stand-alone and 100% equity financed project with no debt financing.

The base case assumes an owner operated mining fleet. A mining contractor scenario has been evaluated in Section 16.5 of the DFS.

The results of the base case financial analysis are summarised below:

Table 1-22: Operational Summary

Description	Unit	Quantity
Ore mined	t	15.4M
Waste mined	t	114.2M
Strip ratio	multiple	7.42
Feed grade	g/t	2.12
Life of mine	years	13
Gold recovery	%	91.5
Gold production	oz	961 333
Gold production (steady-state)	oz/a	95 000

Table 1-23: Summary of Operating Cost (excluding royalty)

Area	Unit	Cost
Mining costs	US$/oz	357
Processing costs	US$/oz	133
General and administrative costs	US$/oz	86
Total cash operating costs	**US$/oz**	**577**

Table 1-24: Financial Summary (post-tax)

Description	Unit	Value
NPV at 8.0 % real discount rate	US$	118M
IRR (nominal, unleveraged)	%	21.9
Net undiscounted cash flow	US$	270M

1.16 HEALTH, SAFETY AND SECURITY

Kefi's HSEC policy as of May 2014 states:

Kefi Minerals Plc and its subsidiaries ("Kefi" or the "Company") are committed to the implementation of a comprehensive Health, Safety, Environment, Labour and Community (HSEC) Policy, ensuring that this policy is made known to all its directors, officers, employees and contractors and that it is proactively implemented, reviewed, and updated.

Kefi has committed to:

- Providing a safe, secure, healthy and productive workplace for all personnel in conjunction with mitigating impact to the environment
- Develop *Health Safety & Security (HSS and ES) and Environmental and Social (ES) Manuals* have been developed by the company to:
  - Provide safe operating procedures specific to worksite activities to assist Kefi in meeting its objectives for Occupational Health and Safety sustainability
  - Requiring that employees, casual staff, contractors, and sub-contractors to actively participate in making our workplace incident and injury free.
- Consider the effects of its activities on the community, also covered in depth by Section 12 of the DFS highlighting its commitment to preventative measures.
- Interact with the Community on daily activities and potential hazards posed from them, as well as emergency contingencies plans or activities that may possibly affect their welfare or environment
- Review Health and Safety (H&S), Environmental and Security policies every three years and more frequently if required due to business developments, operational practice improvements or changes in relevant legislation.
- Cascade all the relevant policies through a number of integral documents, Company programmes, procedures and local operating practices.

Kefi's HSS and ES AND ES policies and procedures, specifically Health & Safety will apply world's best practice and seek to achieve the NOSA 5 Star standard. The NOSA 5 Star system is globally proven to be one of the most effective systems at reducing workplace incidents.

Kefi will also apply world's best practice and work to achieve similar standards in the practice of Environmental Management, Risk Management, Information Security, and Energy Management.

1.17 CONCLUSIONS

KEFI in consultation with all the consultants that produced the DFS, concludes that the Tulu Kapi Gold Project is technically viable based on the detailed evaluation undertaken to definitive feasibility study standards.

SENET, in consultation with KEFI, is also of the opinion that the Tulu Kapi Gold Mine could be constructed and commissioned to be in production by the first quarter of 2017, with construction commencing in the fourth quarter of 2015, subject to successful mitigation of various adverse factors.

The Tulu Kapi Gold Project is an economically attractive mine development. Applying a flat long-term gold price of US$1,250/oz, after-tax cashflows are estimated to total US$270 million. The mine is estimated to produce 961,333 ounces over 13 years at an average cash operating cost of US$577/oz of gold produced.

The main elements of this study comprise:

- Conversion of the Mineral Resource to an Ore Reserve in accordance with the requirements of the JORC Code (2012).
- Comprehensive geotechnical, engineering and hydrological studies in order to complete a detailed mine design and optimisation.
- Metallurgical test work carried out on a range of variability samples taken from across the Resource; both lateral and vertical, enabling a recommended process route to be developed and confirmed.
- Process design and preliminary engineering suitable for cost estimation of the project to within -10 +15 % accuracy. Detailing of all labour requirements and mine and plant consumables, in order to confirm the estimated operating costs.
- A Light Detecting and Ranging (LiDAR) survey over the project affected area to provide topographic contours at 50cm spacing and colour orthographic air photos for the detailed design and engineering of all earthworks (roads, rock dumps, tailings storage facility (TSF) etc.).
- Geotechnical logging and laboratory test work on PQ drill core and pit samples specifically provided to ascertain the characteristics of the soils and rocks of the project area for the detailed design and engineering of all earthworks.
- Design layout and specifications for all the required earthworks to cost estimation requirements.
- Environmental and Social Impact Assessment.
- Estimation of the labour complement to operate the project.
- Preliminary design of the infrastructure required to support the mining, processing and construction operations.
- A study of the in-country road transport conditions.

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SECTION 2 Introduction and Project Background

Tulu Kapi Gold Project
Definitive Feasibility Study

JULY 2015

Golder Associates

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2.1 INTRODUCTION

KEFI Minerals Limited (KEFI) is a gold exploration and development company listed on the AIM Market of the London Stock Exchange (AIM:KEFI) focused on the exploration and concurrent development of the Tulu Kapi Gold Project in Western Ethiopia.

2.2 PROJECT BACKGROUND

The Tulu Kapi Exploration Licence was granted to Minerva Resources through its wholly owned subsidiary GPMC in May 2005, prior to the acquisition of the Project by Dwyka Resources Limited (subsequently renamed to Nyota Minerals Ethiopia Limited or NME) in August 2009.

Various studies were undertaken during the period of 2010 to 2011 to investigate the feasibility of alternative cyanidation process routes to recover the gold from the Tulu Kapi ore. Further extensive exploration and drilling allowed Nyota Minerals to complete a Definitive Feasibility Study (Nyota 2012 DFS) in December 2012 based on a 2 Mtpa processing plant and annual production of 105 000 ounces of gold.

KEFI acquired 100 % project ownership from Nyota Minerals in two tranches – 75 % in December 2013 and the remaining 25 % in September 2014. The Government of Ethiopia is entitled to a 5 % free-carried interest.

KEFI acquired the project with the intention to refine the Nyota 2012 DFS. This process has methodically overhauled the technical and economic characteristics of the Tulu Kapi Gold Project. KEFI's Definitive Feasibility Study (DFS) is based on constructing a conventional 1.2 Mtpa carbon-in-leach (CIL) processing plant and introducing selective mining to increase the planned gold grade of the open-pit ore mined.

2.3 PROJECT DESCRIPTION

The Tulu Kapi Gold Project is located in the Highlands of western Ethiopia, in the Oromia State and in the Genji Woreda administrative district, approximately 360 km due west of the capital Addis Ababa. The Project is approximately 150 km from the Sudan border to the west. The journey by road from Addis Ababa to Tulu Kapi covers a distance of about 520 km and takes approximately 10 hours.

The gold mineralisation at Tulu Kapi is hosted by an Upper Proterozoic age intrusive, which comprises a coarse-grained syenite pluton. These rocks have been intruded into a volcano-sedimentary sequence that was subsequently transformed to mafic and sericitic schists. The main Tulu Kapi deposit comprises a series of stacked gold-bearing quartz-carbonate veins, veinlets and stock work intimately associated with sub-horizontally dipping albite alteration zones.

Land use is predominantly agricultural. The ridges are mainly left to grass for cattle, and the hill sides are terraced for seasonal cropping of maize, teff, corn, and other staples. The incised valleys are overprinted by a forest ecosystem providing shade for extensive coffee plantations, which are the main cash crop.

Rainfall is seasonal with a pronounced monsoon period between July and September. Daily average high and low temperatures range from 32 °C and 13 °C in May immediately prior to the start of the rainy season, to 24 °C and 14 °C in July and August, which are the coldest months.

2.4 TERMS OF REFERENCE

2.4.1 Objectives

The DFS, which is designed to be to an accuracy of +15 % to -10 %, will be used to determine the commercial and technical feasibility of the project. It will include the results of all the work carried out to date, together with conclusions and recommendations for future work.

2.4.2 Consultants' Scope of Services

2.4.2.1 SENET (Pty) Ltd

KEFI requested SENET to act as lead consultant in the compilation of this updated DFS. In addition to a coordinating role, SENET specifically carried out the following:

- Feasibility study coordination
- Metallurgical testwork
- Process plant design
- Infrastructure and logistics
- Project implementation
- Plant and infrastructure capital and operating cost estimates

2.4.2.2 Snowden Mining Industry Consultants (Pty) Ltd (Snowden)

Snowden's scope of services consists of the following:

- Review and update the completed resource estimate to ensure compliance with the 2012 Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (JORC Code).
- Complete and optimise the reserve, mine plan and associated capital and operating cost studies to ensure compliance with the JORC Code.
- Review geotechnical investigations and pit slope design.
- Review hydrogeology.

2.4.2.3 Golder Associates Africa (Pty) Ltd (Golder)

Golder's scope of services consists of the following:

- Revise the entire 2012 Social and Environmental Impact Assessment (SEIA) to reflect the new infrastructure and mine design information.
- Update baseline environmental and social changes that have occurred since the finalisation of the original 2012 DFS, including updates/revisions relating to resettlement actions.
- Update the Closure Plan and costing to reflect the latest mine design.
- Revise the Raw Water Diversion Dam (RWDD) design.
- Revise the Tailings, Return Water, and Raw Water Pipelines/Pumps to reflect the new design.
- Revise the Mine Waste Dump (MWD) to reflect the new design.
- Update the Geotechnical Report for Tailings and Plant Site Infrastructure.
- Update the Water Balance to reflect the design changes.
- Revise the design of the access road to site

2.4.2.4 Epoch Resources (Pty) Ltd (Epoch)

Epoch's scope of services consists of the following:

- Update Tailings Storage Facility (TSF) design to reflect the revised tailings deposition plan.
- Refine the original design to reduce the costs of construction and also to improve the accuracy of the associated estimates of costs. The focus will be on the following:

    - The design of the starter embankment(s) and associated drainage systems based on updated details of the type and availability of soils/waste for construction
    - The surface water diversion works and minimising the volumes of storm water reporting to the TSF

2.5 QUALIFIED PERSONS

2.5.1 Certificate of Qualified Person – Steady Kumwenda

I, Steady Kumwenda, do hereby certify that

1. I am a Principal Process Engineer at SENET Pty Ltd, Building 12, Greenstone Hill Office Park, Emerald Boulevard, Greenstone Hill, Greenstone 1609, Modderfontein, Gauteng, South Africa, and have been employed in this position since 2004.
2. I am a graduate of the University of Zambia, and obtained a Bachelor of Mineral Science (Hons) (Extractive metallurgy and Mineral processing) degree (1984). I also hold a post-graduate certificate in the Management Advancement Programme (2000) from the Witwatersrand Business School – University of the Witwatersrand.
3. I am a practising Process Engineer/Metallurgist and have practised my profession continuously since 1984. I have over 30 years' experience in the minerals industry. I have been involved in the process operation (production) and plant design, from conceptualisation to complete project execution, of more than 20 mineral process projects, as well as more than five process plant studies for major commodities including antimony, coal, cobalt, copper, gold, lead, platinum group metals (PGMs) and zinc.
4. I am a registered professional member of the Institute of Materials, Minerals and Mining (IOM3-UK); a member of the Southern African Institute of Mining and Metallurgy (SAIMM); a Chartered Scientist with the Science Council (UK); and a Professional Engineer with the Engineering Council of South Africa (ECSA).
5. I am responsible for Section 6, and elements of Sections 1, 2, 9, 10, 12, 13 and 14 of the technical report titled "Tulu Kapi Gold Project Definitive Feasibility Study", July 2015.
6. I do not own or expect to receive any interest (direct, indirect or contingent) in the property described herein. I am independent of KEFI Minerals.
7. I have not had any prior involvement with the property which is the subject of the Report.
8. As of the date of this certificate, to the best of my knowledge, information and belief, the Report contains all the scientific and technical information that is required to be disclosed to make the Report not misleading.
9. I consent to the filing of the Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Report.

Dated 17 July 2015

Steady Kumwenda
B.Min Sc (Metallurgy), Pr.Eng (RSA), C.Sci (UK), MIMMM (UK), MSAIMM (RSA)
SENET
Principal Process Engineer

2.5.2 Certificate of Qualified Person – Robin Hounsome

I, Robin Hounsome, do hereby certify that

1. I am an Environmental Project Director at Golder Associates Africa (Pty) Ltd, based in Block C, Bellevue Campus, Bellevue Road, Kloof, Kwazulu-Natal, South Africa, and have been employed in this position since 2007.
2. I am a graduate of the University of Cape Town, and hold a Master of Science degree in Environmental Geochemistry. I am a certified Environmental Assessment Practitioner (since 2003) and a Registered Professional Natural Scientist (400123/96).
3. I am a practising Environmental Scientist and have practised my profession continuously since 1995. I have over 20 years' experience in the environmental services industry.
4. I am responsible for Section 11 of the technical report titled "Tulu Kapi Gold Project Definitive Feasibility Study", July 2015. The aspects of Section 11 dealing with the Resettlement Action Plan and the Community Development Plan were prepared independently.
5. I do not own or expect to receive any interest (direct, indirect or contingent) in the property described herein. I am independent of KEFI Minerals.
6. I have not had any prior involvement with the property which is the subject of the Report.
7. As of the date of this certificate, to the best of my knowledge, information and belief, the Report contains all the scientific and technical information that is required to be disclosed to make the Report not misleading.
8. I consent to the filing of the Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Report.

Dated 17 July 2015

Robin Hounsome
MSc PrSciNat EAPSA

2.5.3 Certificate of Qualified Person – Frank Blanchfield

I, Frank Blanchfield, do hereby certify that

1. I am a Principal Mining Engineer at Snowden Mining Industry Consultants, 181 Adelaide Tce., East Perth, W.A. Australia, and have been employed in this position since 2005.
2. I am a graduate of the University of New South Wales, and obtained a Bachelor of Mining Engineering degree. I also hold a WA Quarry Managers certificate of Competency (unrestricted).
3. I am a practising mining engineer and have practised my profession continuously since 1990. I have over 25 years' experience in the minerals industry. I have been involved in gold mining operations (production) and mine planning, and in gold mining consulting for the last 10 years, from the production and initial planning phases through to feasibility studies, of more than 15 gold mining projects.
4. I am a Fellow of the Australasian Institute of Mining and Metallurgy.
5. I am responsible for Section 5, Ore reserves and Mining, of the technical report titled "Tulu Kapi Gold Project Definitive Feasibility Study", July 2015.
6. I do not own or expect to receive any interest (direct, indirect or contingent) in the property described herein. I am independent of KEFI Minerals.
7. I have not had any prior involvement with the property which is the subject of the Report.
8. As of the date of this certificate, to the best of my knowledge, information and belief, the Report contains all the scientific and technical information that is required to be disclosed to make the Report not misleading.
9. I consent to the filing of the Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Report.

Dated 17 July 2015

Frank Blanchfield
B.E. (Min Eng), FAusIMM
Snowden Mining Industry Consultants
Divisional Manager

2.5.4 Certificate of Qualified Person – Lynn Olssen

I, Lynn Olssen, do hereby certify that

1. I am a Senior Principal Geologist at Snowden Mining Industry Consultants, 181 Adelaide Tce, East Perth, W.A. Australia, and have been employed by Snowden since 2003 and in this position since 2014.
2. I am a graduate of the University of Western Australian, and obtained a Bachelor of Geology in 1993. I also hold a Post Graduate Certificate in Geostatistics from Edith Cowan University in Western Australia (2009).
3. I am a practising geologist and have practised my profession continuously since 1994. I have over 20 years' experience in the minerals industry. I have been involved in gold mining operations and resource estimation, both in a production and consulting environment for the last 20 years, from exploration and feasibility studies through to production.
4. I am a chartered Professional and Member of the Australasian Institute of Mining and Metallurgy.
5. I am responsible for Section 4, Geology, Mineralisation and Exploration, of the technical report titled "Tulu Kapi Gold Project Definitive Feasibility Study", July 2015.
6. I do not own or expect to receive any interest (direct, indirect or contingent) in the property described herein. I am independent of KEFI Minerals.
7. I have not had any prior involvement with the property which is the subject of the Report.
8. As of the date of this certificate, to the best of my knowledge, information and belief, the Report contains all the scientific and technical information that is required to be disclosed to make the Report not misleading.
9. I consent to the filing of the Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Report.

Dated 17 July 2015

Lynn Olssen
Snowden Mining Industry Consultants
Senior Principal Geologist

2.5.5 Certificate of Qualified Person – Guy Wiid Pr.Eng

I, Guy Wiid, do hereby certify that

1. I am a Practising Professional Engineer and Director at Epoch Resources Pty Ltd, Building 22A, The Woodlands Office Park, Woodlands Drive, Woodmead, Johannesburg, Gauteng, South Africa, and have been employed in this position since 2005.
2. I am a graduate of the University of Witwatersrand, from which I graduated with a BSc Eng (Civil) degree (1988) and an MSc Eng (Civil) degree (1995).
3. I have worked as an engineer in the fields of mining waste management and mine closure for a total of 25 years since my graduation. During this time I have been involved in conceptual to detailed design of tailings storage facilities for a variety of commodities including wet and dry ash, gold, platinum, copper, rare earths, iron ore, manganese, coal, and fluorspar in a number of African countries. I have also been responsible for the construction and operational management of a number of such facilities.
4. I am a Professional Engineer registered with the Engineering Council of South Africa (ECSA) (Registration No. 940269), and have been a member in good standing since 1994. I am also an Associate Member of the Southern African Institute of Mining and Metallurgy (SAIMM) and am registered as a Chartered Engineer with the American Society of Civil Engineers (C.Eng, M.ASCE) (Registration No. 9945778).
5. I am responsible for Section 7, and elements of Sections 1, 2, 9, 11, 13, 14 and 18 of the technical report titled "Tulu Kapi Gold Project Definitive Feasibility Study", July 2015.
6. I do not own or expect to receive any interest (direct, indirect or contingent) in the property described herein. I am independent of KEFI Minerals.
7. I have not had any prior involvement with the property which is the subject of the Report.
8. As of the date of this certificate, to the best of my knowledge, information and belief, the Report contains all the scientific and technical information that is required to be disclosed to make the Report not misleading.
9. I consent to the filing of the Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Report.

Dated 17 July 2015

GJ Wiid PrEng
BSc Eng .(Civil) MSc Eng (Civil), C.Eng (M.ASCE), MSAIMM (RSA),
Epoch Resources (Pty) Ltd
Principal Tailings Engineer

2.5.6 Certificate of Qualified Person – Timothy Martin

I, Timothy L. Martin, do hereby certify that

1. I am a Principal Process Engineer at Golder Associates Ghana Limited, Densu Point Building, 3 Wawa Avenue, North Dzorwulu, Accra, Ghana. I have been employed with Golder Associates since 1987 and been based in the Ghana office since 2008.
2. I am a graduate of Washington State University, and obtained a Bachelor of Geological Engineering degree in 1985 and a Masters of Geological Engineering degree in 1986. I also hold a Bachelor of Forest Resource Management degree from the University of Idaho in 1974.
3. I am a practising Geological/Geotechnical Engineer and have practised my profession continuously since 1986. I have over 28 years of diverse experience in geotechnical, mining, and environmental engineering. My experience includes both hydrogeological and geotechnical investigations related to site characterisation, storm water management, construction monitoring, and environmental permitting and compliance. I have been heavily involved in planning and design of waste containment facilities, including mine Tailings Storage Facilities (TSF), hazardous, municipal, and low-level radioactive waste facilities. I have extensive design and review responsibilities with projects involving TSF geotechnical design, pipeline alignments, road and pavement design, slope stability analysis, water impoundments, hydrologic isolation of wastes, closure covers, specifications and bid packages, cost estimates, permit applications, and remedial designs. Since 2008, I have been based in Golder's Accra, Ghana office and have served as the Golder project manager/principal engineer for TSFs and mine infrastructure and environmental assessments for gold, coal, and platinum mine infrastructure projects in Tanzania, Ethiopia, South Africa, Liberia, Ghana, Côte d'Ivoire, and Burkina Faso.
4. I am a registered professional Engineer both in the United States (P.E.) and Ghana (Ing.). I am a member of the American Society of Civil Engineers (ASCE) and a member of the Ghana Institute of Engineers (MGhIE)
5. I am responsible for Section 7, specifically, Waste Management, Tailings, and, Water Management of the technical report titled "Tulu Kapi Gold Project Definitive Feasibility Study", July 2015.
6. I do not own or expect to receive any interest (direct, indirect or contingent) in the property described herein. I am independent of KEFI Minerals.
7. I have not had any prior involvement with the property which is the subject of the Report.
8. As of the date of this certificate, to the best of my knowledge, information and belief, the Report contains all the scientific and technical information that is required to be disclosed to make the Report not misleading.
9. I consent to the filing of the Report with any stock exchange and other regulatory authority and any publication by them for regulatory purposes, including electronic publication in the public company files on their websites accessible by the public, of the Report.

Dated 17 July 2015

Timothy L. Martin

Timothy L. Martin
MSc, P.E., Ing.
Golder Associates Ghana Limited
Principal and Senior Consultant

2.6 SITE VISITS AND SCOPE OF PERSONAL INSPECTIONS

All of the consultants involved in the execution of the DFS have had the opportunity to visit the Tulu Kapi Gold Project. During these site visits, the existing KEFI Minerals exploration camp was used as a base camp. The majority of the consultants from the 2012 DFS were retained.

2.6.1 SENET's Site Visits

2.6.1.1 Site Visit 1

Between 26 September 2011 and 01 October 2011, a team of four SENET Engineers visited Addis Ababa and the Tulu Kapi project site. During this visit, the opportunity was taken to assess the Tulu Kapi site terrain and review the location of the pit to identify suitable process plant locations. Existing site conditions, infrastructure and access roads were also assessed.

Part of the team returned from site to Addis Ababa by road to do an early assessment of road conditions while the balance returned by light aircraft and took the opportunity to review the terrain for the incorporation of a new overhead power line from Gimbi to the project site.

In Addis Ababa, the team reconsolidated and used available time to meet with as many local companies as possible to do a high level determination of local skills available to support the construction of the process plant.

2.6.1.2 Site Visit 2

A second Site Visit was attended by a Project Engineer between 18 March 2012 and 23 March 2012. The purpose of this site visit was to review decisions made on the location of infrastructure and to conclude interfaces between consultants.

2.6.2 Golder's Site Visits

2.6.2.1 Social and Environmental Impact Assessment Site Visits

Five consecutive project site visits were made by JEMA International Consulting PLC (JEMA) team members in the month of October 2010. Subsequent field visits were also made on November 2010, December 2010, and April 2011. Activities undertaken in the course of the field investigation and purposes of each activity are as discussed below. In addition, SRK's team of air and water specialists undertook site visits in October and November 2010 with the objective of setting up monitoring networks for water quality and quantity monitoring and air quality monitoring. These site visits were undertaken in parallel with the JEMA site visits to ensure that information transfer took place effectively.

In updating the SEIA, the team has undertaken a number of site visits while evaluating the baseline conditions on site. These are shown in Table 2-1.

Table 2-1: Description of Site Visits

Nature of Site Visit	Description
Biodiversity (undertaken by Mr Habte Jebessa)	• A floristic/vegetation survey was carried out in October 2011 to describe the floral and vegetation types and to assess the possible impacts of the proposed gold mine on the plant diversity in the Project Area. • Fauna (mammals, avifauna and amphibians): an eight-day site visit was conducted in October and November 2011. During the visit, the observed and derived presence of fauna associated with the recognised habitat types of the study site was recorded. This was done with due regard to the known distributions of Ethiopian fauna. • Wetlands: a wetland assessment was carried out in October 2011 to describe the wetland status and to assess the possible impacts of the proposed gold mine on the wetlands ecology in the Project Area.
Water quality and Hydrocensus	Two site visits were undertaken to sample water and evaluate downstream water use in November 2011 and again in May 2012 (by Lamessa Mekonta and Catherine Hughes). The following methodologies were used for the investigations of the current hydrocensus and water quality: • Identifying and interviewing people/users at every water use point along rivers and streams to estimate the number of water users and to understand the purpose of the water use. • Water sampling from different representative sources for microbiological, physiochemical and heavy metals/trace element analysis at field level and laboratory level • Data analysis, synthesising and report writing
Groundwater	Two previous phases of investigation that relate to hydrogeological characterisation at the site were conducted: • SRK's PEA investigations of 2010 • WAI's investigation from December 2011 to May 2012 Both of these investigation programmes involved the use of geotechnical and exploration programmes for the hydrogeological investigation.
Soils Survey	A detailed soils survey was undertaken in January 2012 by Ato Solomon. Data collection was carried out using a grid survey method, in which observations were made at evenly gridded lines with an average observation density of one per 25 ha. Grid transects were laid 500 m apart and auger observations were made at 500 m intervals along each transect. A total of 40 auger hole observations were made and soil mapping units identified. After a proper identification of soil mapping units, eight soil pits were opened and their environmental and morphological characteristics were described. All eight pits were sampled (two samples from each pit) and a total of 16 samples in disturbed structures were collected from the eight profiles at depths of 0 to 25 cm from the top soil (A-horizon) depending on the fertile horizon thickness, and at 50 cm to 75 cm depth or subsoil (B-horizon). Profile pit locations and field and environmental descriptions of the soils were recorded.
Archaeological and Cultural Heritage	• Desktop research was conducted to establish the historical and regulatory context for this study. Community consultation was carried out during a visit to the affected areas by Dr Temesgen in order to contact the relevant local government bodies, elders and inhabitants. Reconnaissance surveys were conducted in the project area with the help of local Community Members from 17-25 • December 2011. Whenever possible, local knowledge and memory were used to describe cultural heritage sites and symbolic landscapes, particularly in the case of burial sites of religious institutions such as churches or mosques.

Nature of Site Visit	Description
Social Infrastructure and conducting a baseline survey of socio-economic conditions	The SIA methodology consisted of a desktop literature review and fieldwork activities undertaken by Mehari Belachew. In addition, stakeholder engagement was conducted with stakeholders located on the site and in the surrounding communities as part of the implementation of the Stakeholder Engagement Plan.

In addition to the above, the Golder SEIA management team (led by Rob Hounsome) visited the site on two occasions – in September 2011 and again in May 2012. The purpose of these visits was to understand on-site conditions and to ensure that fieldwork was progressing effectively.

2.6.2.2 Site Visit 1 – 08 to 11 September 2011

Rob Hounsome (Golder), Tim Martin (Golder), and Golder's TSF sub-consultant, Guy Wiid (Epoch) visited the Tulu Kapi Gold Project site to assess the terrain and specifically to review several potential locations for the TSF. They also visited and reviewed potential locations on site for an airstrip.

2.6.2.3 Site Visit 2 – 12 to 17 February 2012

Tim Martin (Golder) and Golder's Ethiopian road engineer sub-consultant, Chalachew Abebe (ATTCO) walked the proposed alignments for the primary access road from Keley to Tulu Kapi and the Southern Bypass road. This on-site review included evaluations of alternate adjustments in the alignments to minimise impacts to the community with respect to crops and structures.

2.6.2.4 Site Visit 3 – 18 to 23 March 2012

Tim Martin (Golder) met with representatives from SENET and Wardell Armstrong International to review the site infrastructure including the potential construction quarry locations, mine waste dump locations, access roads, ROM pad location, process plant location, explosive storage facility, administration building, maintenance facility and the TSF location.

2.6.2.5 Site Visit 4 - 20 April to 1 May 2015

Michael Van Niekerk (Golder) visited the Tulu Kapi Project site to assess at a high-level the affected household's use of and dependence on ecosystem services. During the visit, Golder walked the proposed new access road to confirm no changes had occurred in terms of environmental and social impacts since the previous site visit in 2014, conducted water sampling downstream of the new southern WRD, as well as a survey of downstream water users, visited and reviewed the accepted resettlement sites, and met with the relevant Woreda and Kebele officials to communicate to them the updated SEIA findings.

2.6.3 Snowden's Site Visits

Snowden's Principal Consultant, John Graindorge, visited the Tulu Kapi site in Ethiopia on 19 to 22 July 2014. Discussions were held with various KEFI personnel, most of whom were present during the previous drilling programmes including those conducted by Nyota. All aspects of the sample collection, sample preparation, QAQC and assaying were reviewed with the site personnel. Additionally, the general site geology was assessed from the diamond drill core and the available outcrop, including altered syenite and mineralised quartz veins.

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SECTION 3 Property Description and Location

Tulu Kapi Gold Project Definitive Feasibility Study

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3.1 PROJECT LOCATION

The Tulu Kapi Gold Project is located in Western Ethiopia, in the Western Wellega Zone of the Oromia Region approximately 360 km due west of the capital, Addis Ababa. The Project is accessible by road from Addis Ababa, a distance of 520 km with the final 15 km by means of an all-weather unpaved road running through the surrounding villages. The journey by road from Addis Ababa to Tulu Kapi takes approximately 10 hours.

The project area is approximately 9 km south of the village of Kelley, which is on the main road from Gimbi to Dembi Dollo. Regional population centres within easy road travel distance of the licence areas include Ayra, a small town about 20 km to the west, Gimbi, an important market town about 32 km to the east northeast, and Nekemte, a larger regional centre about 110 km to the east.

Chartered aircraft from Addis Ababa may land at an airstrip at Ayra Guliso, approximately 30 km by road from the project. Road travel from Ayra to the project site takes approximately 2 hours on a mix of gravel and dirt roads. Ethiopian Airlines operate scheduled flights three times a week to Assosa airport, a 4-hour drive from Tulu Kapi.

The Sudanese border is approximately 150 km due west of the project area.

The project location area is shown in red in Figure 3-1.

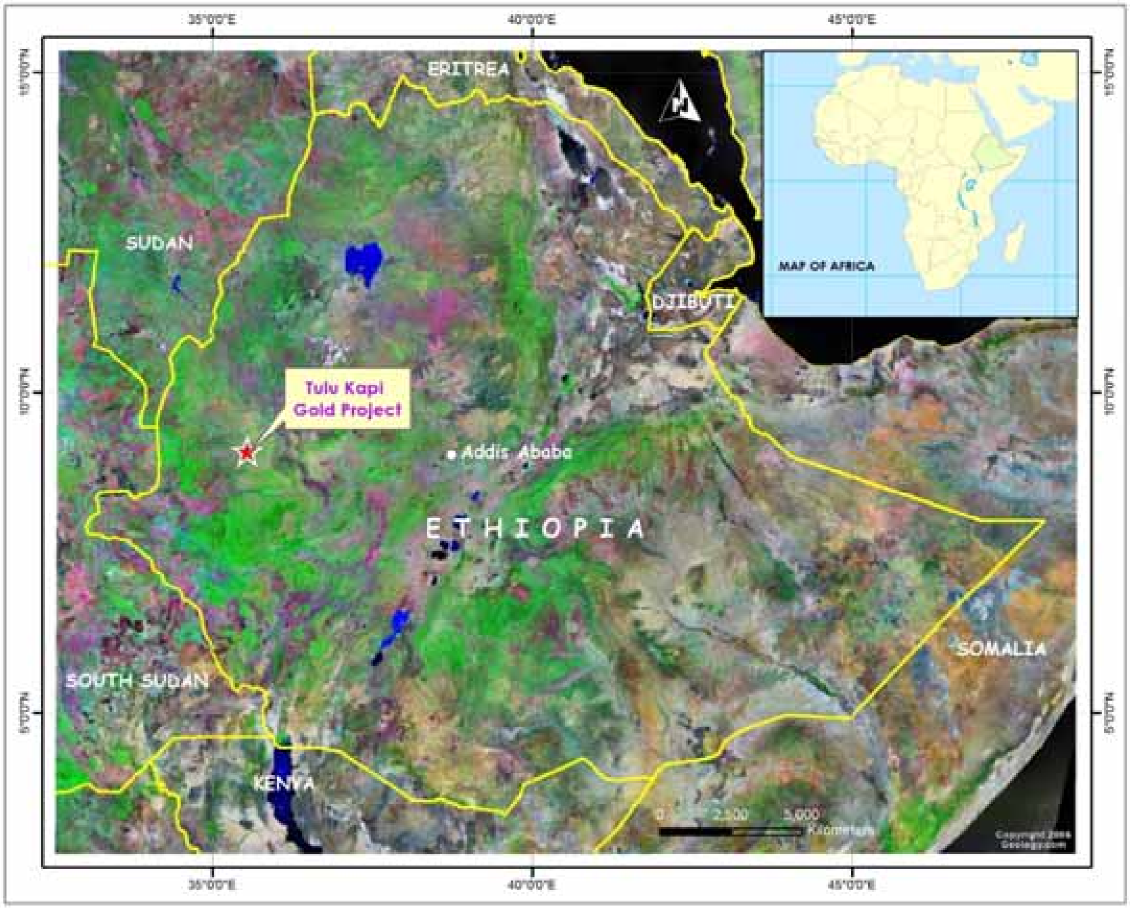

Figure 3-1: Tulu Kapi Gold Project Location

3.2 PROJECT HISTORY

Small-scale surface mining took place at Tulu Kapi in the 1930s, focussing on easily accessible gold-bearing saprolite on the flanks of the Tulu Kapi deposit. The total volume of material mined was modest and has had little or no impact on the project resource or future mining plans and there has been no history of persistent artisanal mining.

Tulu Kapi was first mentioned in dispatches by Jelenc in his book, "*Mineral Occurrences of Ethiopia*", published by the Ministry of Mines of Ethiopia, 1966.

Jelenc mentions the presence of small-scale surface mining of saprolite ore at a number of sites on and around the Tulu Kapi Hill thought to be the work of SAPIE, an Italian company that in 1939 reported a resource of 947 000 m^3 at a grade of 1.22 g/m^3, for a total of 1 155 kg (about 37 000 oz) of gold.

The earliest modern exploration of the Tulu Kapi area took place in the 1970s under the guidance of the United Nations Development Programme (UNDP), which undertook reconnaissance exploration over a wide area of western Ethiopia between 1969 and 1972. The work was largely reconnaissance level and regionally biased and included stream sediment and soil geochemical sampling, geophysical surveys, detailed geological mapping and diamond drilling.

Tan Range Exploration Company (TREC), a Canadian exploration company, acquired an exploration licence over an area that incorporated the Tulu Kapi deposit and undertook further exploration between 1996 and 1998, including a small amount of drilling.

The Tulu Kapi Licence was granted to Minerva Resources through its wholly owned subsidiary Golden Prospect Mining Company (GPMC) on 27 May 2005. GPMC undertook further detailed geological mapping, trenching, and geophysics and completed 34 diamond drill holes. GPMC adopted the data generated by TREC, who geo-referenced it to UTM co-ordinates from local grids.

Minerva Resources (GPMC's parent company) was acquired by Dwyka Resources Limited (whose name was subsequently changed to Nyota Minerals Limited) in July 2009. GPMC therefore became a wholly owned subsidiary of Nyota.

Between July 2009 and September 2011, Nyota undertook an aggressive exploration and evaluation programme, which has been summarised by independent geological and mining consultants in several JORC-compliant mineral resource estimates and an NI 43-101 PEA.

Further extensive exploration and drilling allowed Nyota to complete a Definitive Feasibility Study (DFS) in December 2012 based on a 2 Mtpa conventional carbon- in- leach (CIL) processing plant and an annual production of 105 000 ounces of gold.

KEFI Minerals Plc acquired 75 % of the share capital of Nyota Minerals (Ethiopia) Ltd (NME), the owner of the Tulu Kapi Project and surrounding exploration licences, in December 2013. NME underwent a name change in 2014 to KEFI Minerals (Ethiopia) Ltd (KME). KEFI announced the acquisition of the remaining 25 % of KME in June 2014. The sale was approved by Nyota Minerals Ltd shareholders in September 2014, giving KEFI 100 % ownership of KME and the Tulu Kapi project. The Government of Ethiopia is entitled to a 5% free-carried interest.

Since December 2013, KEFI has conducted exploration and further drilling activities to update study documents for re-submission of a mining licence application (MLA) in October 2014.

The former exploration licence that encompasses the Tulu Kapi project was replaced by a Mining Licence on 13 April 2015. This licence gives KEFI the right to build and operate a mine. When the licence was issued, the Company also signed a Mineral Agreement with the Government of Ethiopia, which sets out the fiscal regime, taxation and royalties as they affect the operation of the mine. The licence and mineral agreement were signed by KEFI and the Company's wholly owned subsidiary in Ethiopia, and are valid for 20 years. The mining licence can be renewed, with each renewal subject to a maximum period of 10 years.

3.3 PROJECT DESCRIPTION

The 7 km^2 Mining Licence Area is located in the Oromia National Regional State, Western Wellega Zone, Genji Woreda (Kapi Guracho and Bikiltu Ankore Kebele).

Figure 3-2 shows the mining licence area for the Tulu Kapi Gold Project overlaid on an aerial photograph.

Geographic co-ordinates and the co-ordinates of the corner points of the mining licence area are given in Table 3-1 and Figure 3-3.

The project area is characterised by rounded hills and deeply incised valleys at elevations of between 1 550 and 1 770 metres above mean sea level.

The project site is located on a ridge forming a watershed which drains north and south. Drainage to the north is towards the Gurach and Kersa Rivers, which are sub-tributaries of the Birbir River. Drainage to the south is via the Chalte, Kumbo and Sarere rivers, which are sub-tributaries of the Baro and Blue Nile Rivers. The streams in the area are perennial but decrease to very low flow rates in the dry season. Groundwater in the project area is found in two aquifers. The upper unconfined aquifer is located in the saprolite, and the lower semi-confined aquifer is located deeper in the fractured bedrock. Groundwater flow is expected to mimic the surface topography and be controlled by surface water divides.

Land use is predominantly agricultural and the ridges are mainly left to grass for cattle. The hill sides are terraced for seasonal cropping of maize, teff, corn, and other staples. The incised valleys are overprinted by a forest ecosystem providing shade for coffee plantations.

Rainfall is seasonal with a pronounced “monsoon” period between July and September. Daily average high and low temperatures range from 32 °C and 13 °C in May immediately prior to the start of the rainy season, to 24 °C and 14 °C in July and August, which are the coldest months.

KEFI has been able to continue uninterrupted exploration throughout the year, including reduced activity during the wet season, and based on evidence to date there appears to be no reason why a commercial- scale mining and processing operation cannot be conducted throughout the year.

The gold mineralisation at Tulu Kapi is hosted by an Upper Proterozoic Age intrusive, which comprises a coarse- grained syenite pluton. These rocks have been intruded into a volcano-sedimentary sequence that was subsequently transformed to mafic and sericitic schists. The main Tulu Kapi deposit comprises a series of stacked gold-bearing quartz-carbonate veins, veinlets and stock work intimately associated with sub-horizontally dipping albite alteration zones.

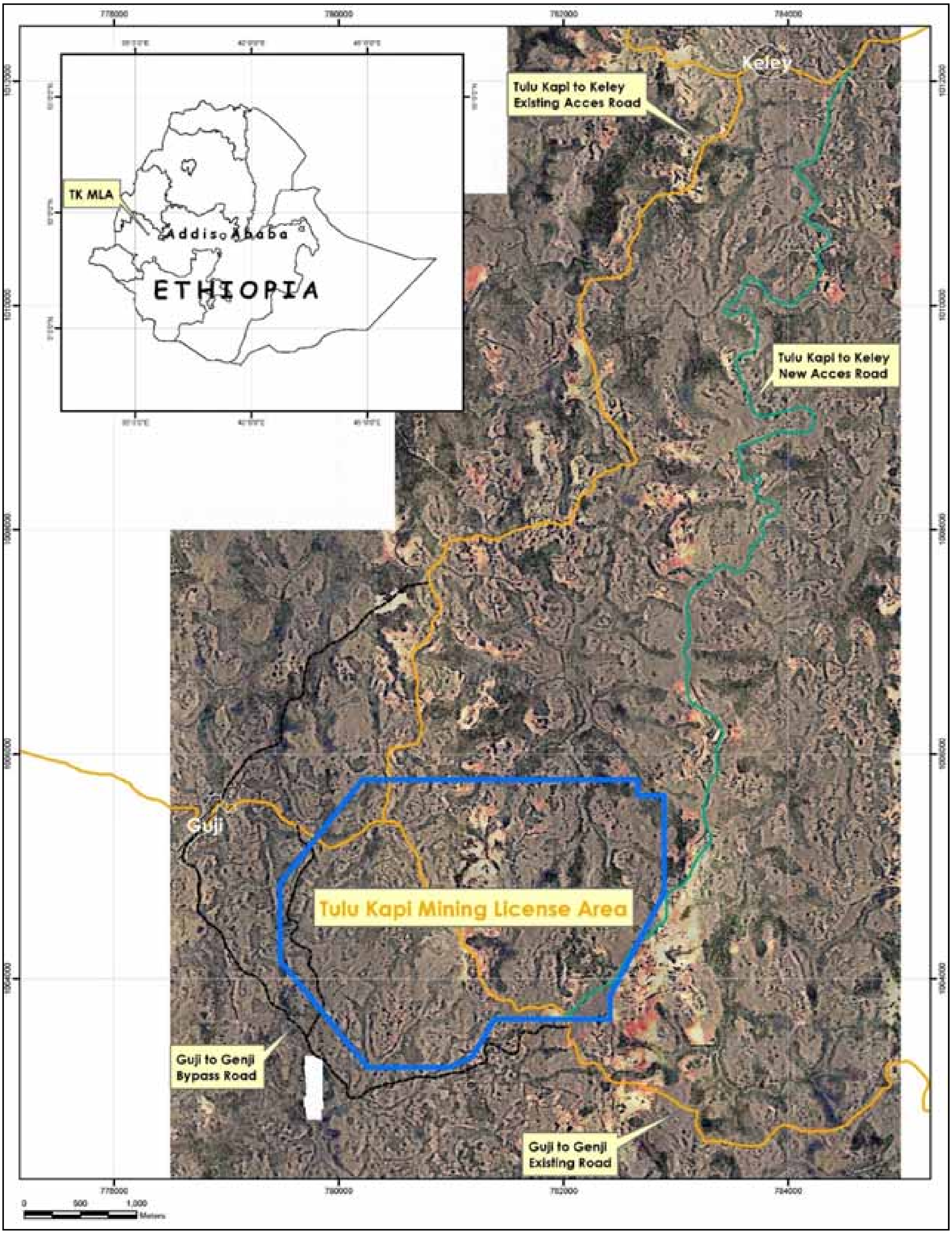

Figure 3-2: Tulu Kapi Mining Licence Area

Table 3-1: Tulu Kapi Gold Project Mining Licence Area

Corner Point	Longitude (Degrees East)	Latitude (Degrees North)
	Degrees, Minutes, Seconds	Degrees, Minutes, Seconds
A	35,32,58.08	9,04,0.33
B	35,33,21.64	9,04,0.17
C	35,33,28.47	9,04,03.21
D	35,33,35.09	9,04,13.90
E	35,34,08.70	9,04,13.67
F	35,34,08.75	9,04,20.37
G	35,34,24.74	9,04,50.12
H	35,34,24.94	9,05,18.32
I	35,34,17.18	9,05,18.37
J	35,34,17.22	9,05,22.99
K	35,32,57.10	9,05,23.56
L	35,32,32.90	9,04,53.76
M	35,32,32.74	9,04,31.16

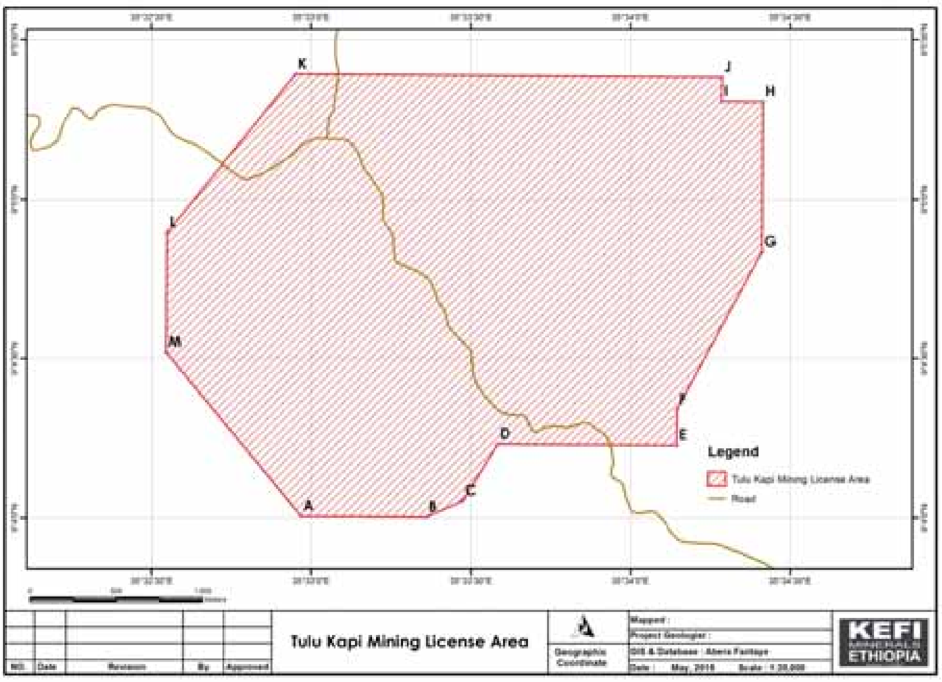

Figure 3-3: Co-Ordinates of the Corner Points – Tulu Kapi Mining Licence Area

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SECTION 4 Geology, Mineralisation and Exploration

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4.1 INTRODUCTION

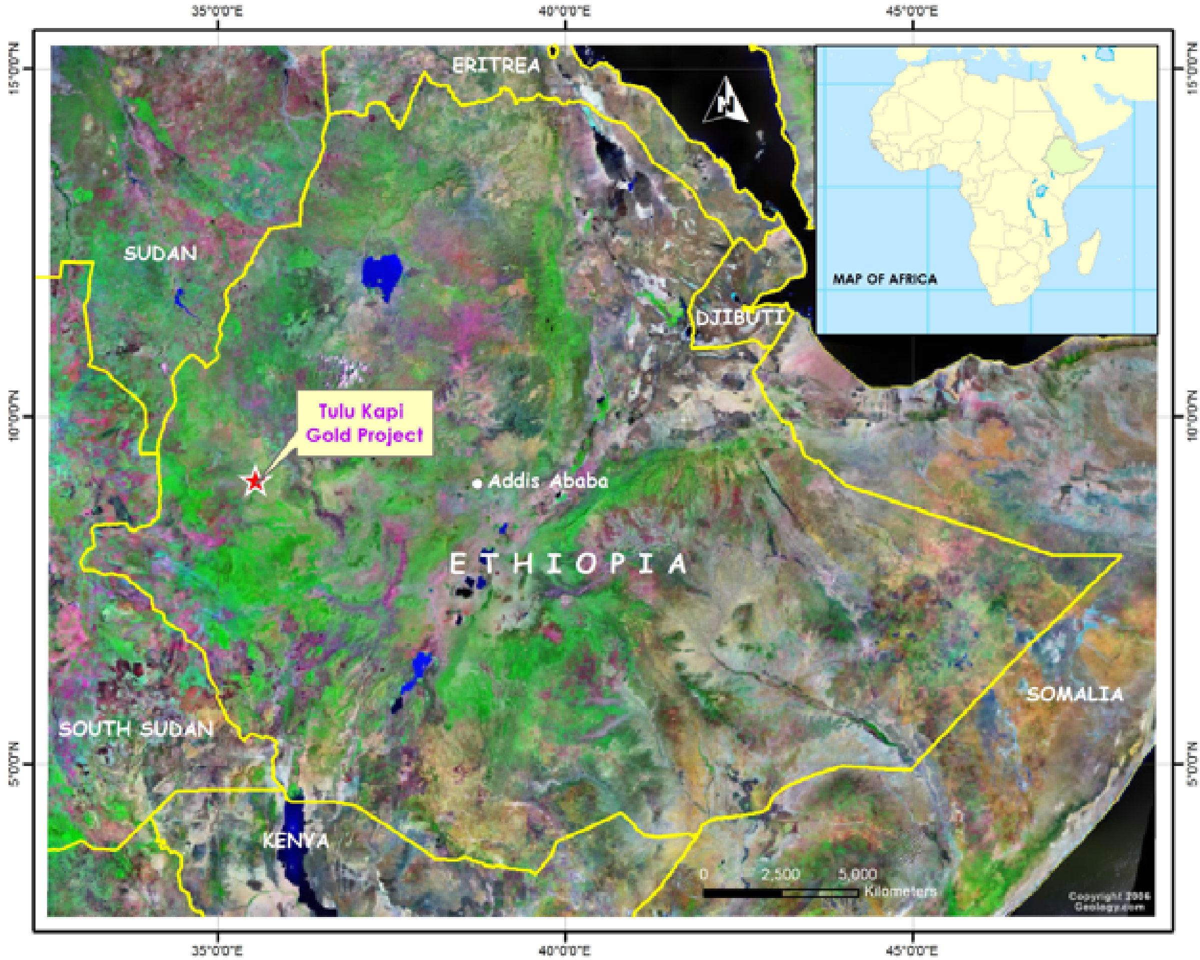
This report section documents the resource estimate compiled by Snowden and KEFI in January 2015. The scope of work included the following:

- Assisting KEFI with the generation of the resource estimate and reviewing each step of the process, including the following:
    - Importing the drill hole geology and assay data and completing basic data validation of the drill hole data
    - Review, analysis and documentation of the QA/QC data
    - Review of the mineralised domain wireframes created by KEFI
    - Compiling of summary statistics and variography for gold and determining top cuts
    - Estimating the gold block grades using dynamic anisotropy and ordinary kriging using top cuts
    - Validating the estimate against the composited drill hole data
    - Classifying and reporting the Mineral Resource based on the guidelines of the JORC Code (2012)
    - Comparisons to the previous Mineral Resource
    - Compilation of a detailed resource report describing the work that was completed and the results of the study

NOTE: Snowden carried out a site visit from 17 July 2014 to 23 July 2014. No additional drilling or mining has been carried out since the completion of the site visit.

4.2 PROPERTY DESCRIPTION AND LOCATION

The Tulu Kapi gold project is located in western Ethiopia approximately 350 km due west of the capital, Addis Ababa (see Figure 4-1). Access to the project is by road and involves a 10-hour road trip on roads sealed with tar or on unsealed roads with no asphalt from Addis Ababa to the project site.



Source: KEFI

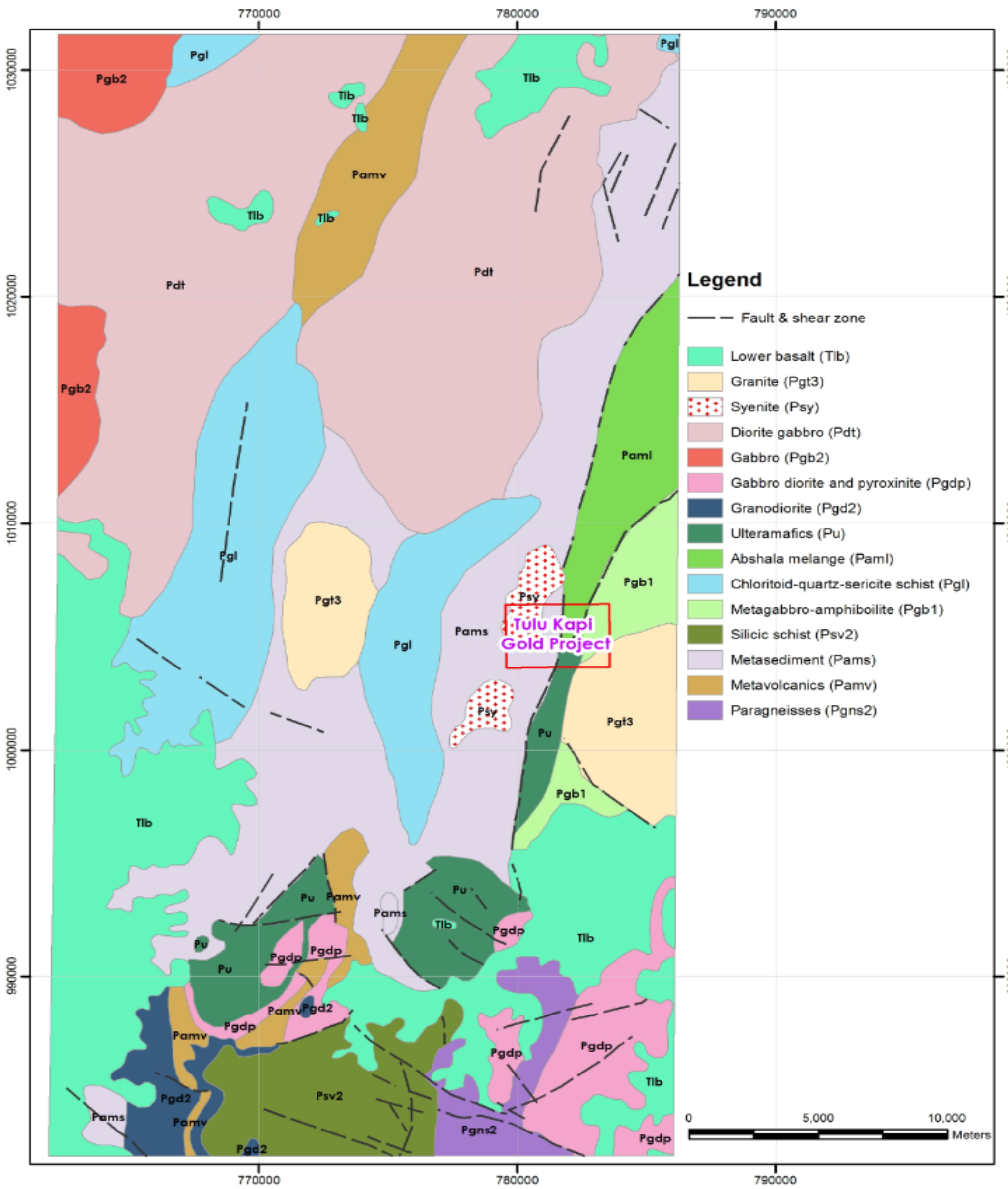
Figure 4-1: Location Map of Tulu Kapi

4.3 GEOLOGICAL SETTING

This section has been sourced and updated from WAI (2012).

4.3.1 Regional Geology

Tulu Kapi is located within the Arabian-Nubian Shield which consists of Archean (Upper Proterozoic rocks more than 800 Ma) gneiss making up a granite-greenstone terrain. Additional weakly metamorphosed volcano-sedimentary successions of late Proterozoic age occur within this terrain. The area has been extensively folded, faulted and intruded by Pan-African aged granites and lesser mafic to ultramafic intrusives and hosts a number of gold occurrences/deposits. A major regional shear is located to the southeast of the Tulu Kapi area and strikes northeast-southwest for more than 100 km. A map of the regional geology is shown in Figure 4-2.



Source: KEFI

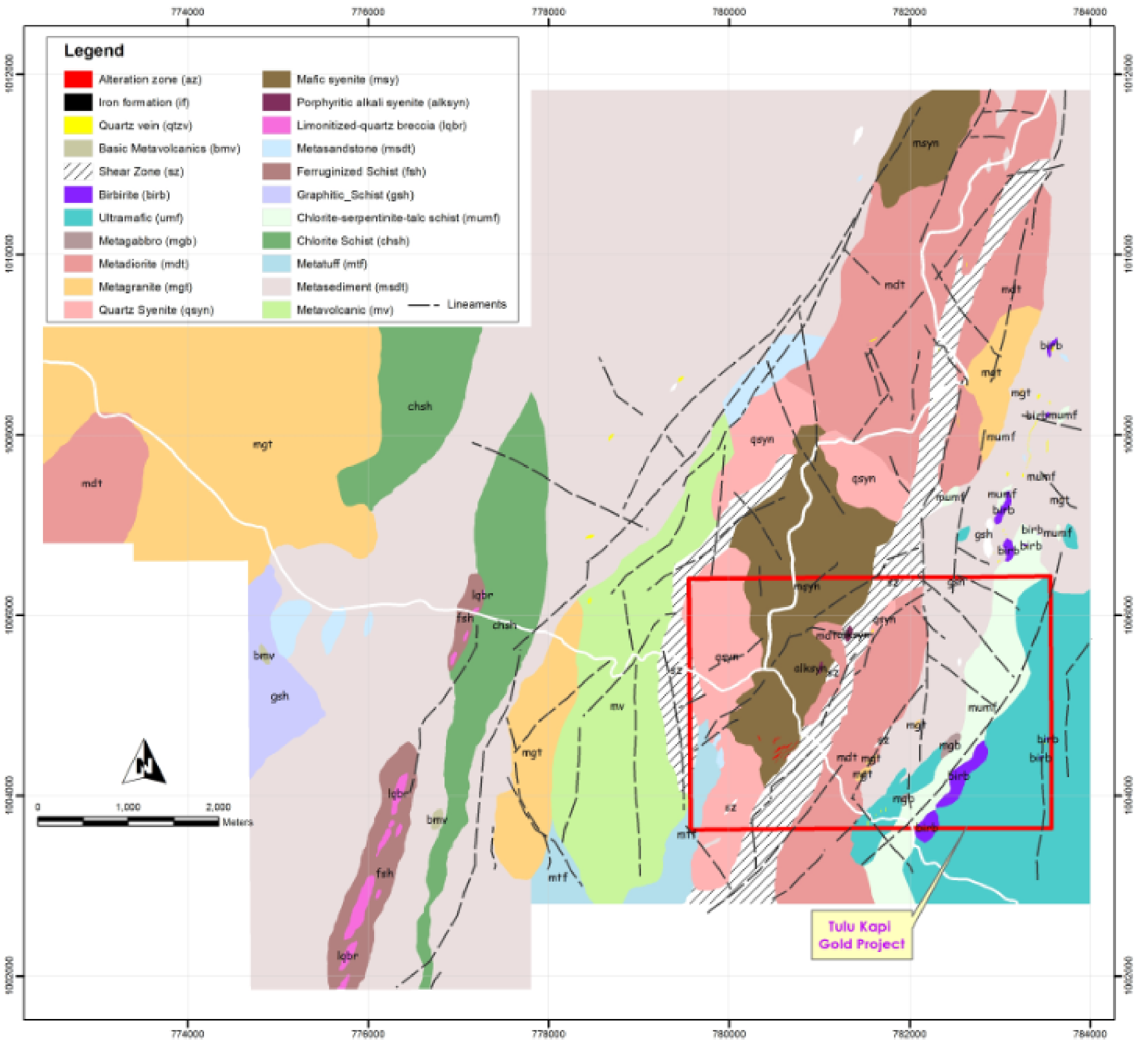
Figure 4-2: Map of Regional Geology

4.3.2 Local Geology

The Tulu Kapi area consists of rocks ranging from Pre-Cambrian to Tertiary in age. The gold mineralisation at Tulu Kapi is hosted by an Upper Proterozoic age intrusive, which comprises a coarse-grained syenite pluton. These rocks have been intruded into a volcano-sedimentary sequence that was subsequently transformed to mafic and sericitic schists. A map of the local geology is shown in Figure 4-3.

The following identifiable units are associated with the Tulu Kapi deposit and from oldest to youngest comprise:

- Basement granitic gneiss
- Meta-sedimentary units
- The Birbir Group basement rock
- Quartzites
- Ultramafics
- Mafics and intruded metagabros
- Metadiorites
- Metagranites
- Syenites



Source: KEFI

Figure 4-3: Map of Local Geology

The southern and eastern limit of the main Tulu Kapi deposit is defined by a northeast-southwest trending shear zone (the Bedele shear zone), which ranges in thickness from 20 m to 60 m. The shear zone dips to the northwest. Near surface the angle of dip of the shear zone is approximately 65° while at depth the angle shallows to around 30°. The hanging wall contact of the shear zone contacts the syenites, which host the Tulu Kapi deposit, whilst the footwall contacts diorite. Within the area of the shear zone, the syenite has been altered to sericitic schist, whilst the diorite has been altered to mafic schist.

The shear contact is considered to be complex with deep drilling having identified appreciable gold grades within the diorite located beyond the shear. In addition, the most recent deep diamond drilling has identified particularly high gold grades at depth within the syenite close to the shear zone. The exact nature of the shear zone contact has not yet been fully confirmed and drilling beyond the shear will have to be carried out to investigate and confirm the presence of gold grades within the diorite. This represents a potential benefit for the Tulu Kapi project.

The northern limit of the main Tulu Kapi deposit is defined by a dyke infilled minor northeast-southwest trending fault. The area to the north of this fault is referred to as the UNDP target area. Exploration of the UNDP target area is ongoing and the extent of the mineralisation has not been fully defined, although gold grades appear to be generally lower in this area. Equally, the western extent of the deposit has not yet been fully defined.

The Tulu Kapi primary mineralisation is hosted in mafic syenite. The unaltered syenite is predominantly a medium to coarse-grained rock composed of 60 % to 70 % pink to white alkali feldspar, 20 % to 25 % plagioclase, and 10 % to 15 % ferromagnesian minerals and minor interstitial quartz. The ferromagnesian minerals appear to consist mainly of biotite with minor amphibole and magnetite. The mineralisation is associated with shallow (approximately 30°) northwest dipping zones of dense quartz-veining, enveloped by an auriferous highly albitised, metasomatic alteration centred on the Bedele shear zone.

The albitised zones are of a lensoid nature comprising discrete stacked bodies that pinch and swell both along strike and down dip. A gradational contact of only a few centimetres with the unaltered mafic syenite is exhibited and the thickness of the individual albitised zones is highly variable. Mafic rocks (dolerite) representing dykes and/or sills are present within the syenite and are up to 10 m in thickness.

The dolerites range from fine-grained to porphyritic. The rocks are logged as mafic dyke, mafic schist and mylonite. Large-scale fault structures trending northeast-southwest have been identified within the Tulu Kapi deposit, but the displacement of the mineralisation is minor. It is not known whether these structures are syn or post-mineralisation in age. Smaller-scale late-stage fault structures that trend northwest-southeast are also thought to be present within the Tulu Kapi area.

4.3.3 Deposit type

The main Tulu Kapi deposit comprises a series of stacked gold-bearing quartz–carbonate veins, veinlets and stock work intimately associated with sub-horizontally dipping albite alteration zones.

The mineralisation and alteration are hosted by a syenite pluton into which a swarm of dolerite dykes and sills have been intruded. The sills appear to be parallel to the sub-horizontal dipping albitised zones.

The vein zones, sometimes, referred to as lode structures, are generally hosted by syenite with evidence of ductile fabric and deformation in some areas, including the altered and veined zones near the Bedele shear zone and dolerite dykes and sills. These observations have led to the view that mineralisation at the Tulu Kapi deposit is of the mesothermal 'lode' type gold deposit, which is pluton-related and orogenic which is structurally controlled in origin. Consensus is that the syenite is unlikely to be the source of the gold-bearing fluids and exploration efforts continue in an effort to better understand and locate a suitable intrusion that acted as the source and/or pathway for mineralisation.

At depth beneath the main body of mineralised syenite there is the so-called "the deeps". This zone is adjacent to the Bedele shear and is characterised by significantly higher gold grades, with occasional coarse visible gold, more base metal sulphides and a shallower apparent dip that the main orebody above it.

The current view relating to emplacement considers that the shear zone represents a structure created by reactivation of a former vein–fault zone and that this reactivation caused the brittle syenite intrusion to itself shear, bounded to the north by a sub-parallel fault, forming a series of low angle faults that provided the conduit for both the swarm of dolerite sills and mineralising fluids. The albitisation and mineralisation associated with these low-angle faults are thought to have been subjected to a later stage of faulting which displaces the lodes.

On drill traverse line 240 S, the drill core provides evidence of mineralisation, being buckled and boudinaged where it encounters the shear zone, which eliminates the possibility of the deformation being related genetically to the vein zone development. The shear zone does not appear to have caused any significant offset of the mineralised zones as mineralisation is observed in diorite that is in contact with the shear and the upper mineralised zone.

4.3.4 Mineralisation

Mineralisation is contained within albitised zones of a lensoid nature, which comprise discrete stacked bodies that pinch and swell both along strike and down dip. A gradational contact with the unaltered mafic syenite is exhibited and the thickness of the individual albitised zones is highly variable.

Mineralisation is generally pervasive and disseminated throughout the albitised syenite (see Figure 4-4) and is also associated with quartz veins and fractures. Generally, the albitised zones are observed to contain sulphide mineralisation and are generally also gold-bearing with silver occurring as an associated mineral at low grades. However, in drill hole TKBH074 it was observed that albitisation and abundant sulphide mineralisation were apparent in certain intersections; however, no gold was present (based on the assay results). It is therefore possible that gold may have some correlation with the presence of pyrite, however, not all pyrite-rich intersections are gold-bearing.

Source: Snowden

Figure 4-4: Mineralisation Outcrop – Albite Altered Weathered Syenite

These visual and simplistic spatial relationships led initially to the description of gold "lodes" in the geological model. Subsequent data analysis and interpretation have moved away from this terminology because of the more complex relationships that are exhibited between gold occurrence, syenite alteration and structure.

The sulphide mineralisation is characterised by a simple mineral assemblage comprising gold, pyrite and minor silver, sphalerite and galena. At depth, the mineralogy changes with more intense base metal sulphide mineralisation with significant sphalerite, galena and minor arsenopyrite and chalcopyrite along with gold, silver and pyrite. Other than gold, and to a lesser degree silver, all other associated minerals are present in such minor qualities so as to form an insignificant presence within the deposit.

Although a number of detailed mineralogical and petrographic studies have been completed since 2007, no significant presence of silver mineralisation has been noted and all studies refer to Tulu Kapi as a gold deposit. The gold:silver ratio is typically around 2:1 (metallurgical test work gives an average of 22:10) with silver being assumed to be present in the form of both native silver and to a lesser degree as calaverite, a gold telluride with up to 3 % silver content, or as sylvanite, a gold-silver telluride.

Sufficient metallurgical testwork has been completed to confirm that the relative concentrations of iron, zinc, lead, copper and arsenic are at sufficiently low levels to have no impact on metallurgical processing and gold recovery. Similarly, multi-element analyses of 36 elements in drill holes has confirmed that the grades (g/t or %) of these associated metals is so low as to be uneconomic.

The recovery of silver is unavoidable as this associated element is attracted to activated carbon in the CIL process along with gold. Fortunately, from a metallurgical perspective, the silver grade is low and does not have a detrimental impact on the ability of the activated carbon to maximise gold recovery.

Albitisation is associated with a bleached colouration to the host syenite. Textural replacement of the host syenite involves alteration of all feldspars to albite. The alteration also involves the replacement of the mafic minerals with sulphides. The ferromagnesian minerals have been completely removed during alteration, leaving voids. These voids have in turn been infilled by pyrite, which is also disseminated throughout the albite zone. Pyrite crystals are generally 2 mm to 4 mm in width and can reach up to about 1 cm.

The alteration produces zones that are up to several metres wide and can be visually identified in outcrop and in the drill core as having a white bleached colouration. Gold and low-grade silver are generally only associated with the albitised zones (including gold contained within quartz veins and fractures), however, there does not appear to be any correlation between the degree of albitisation and gold and silver grades.

From petrography work, the gold occurs on the grain boundaries and fractures within sulphides. The gold grains vary from 1 µm to 300 µm with an average of about 11 µm. Visible gold is occasionally seen in core, and nuggets have been found in gullies and streams at surface following the wet season.

In 2007, GPMC commissioned a gold study in order to understand the types of alterations associated with the Tulu Kapi type of gold mineralisation, the paragenesis of the gold deposition and to establish an appropriate mineral processing technique. The study showed that the most abundant type of sulphide associated with the gold is pyrite, followed by sphalerite, bornite, chalcopyrite, galena, arsenopyrite and tetrahedrite-tennanite. The absence of gold in arsenic, tellurium and antimony sulphide minerals was encouraging with respect to the gold metallurgy. It was also later confirmed by Nyota with more detailed metallurgical testwork conducted in 2010, which suggests that little of the gold present in the samples could be incorporated in such minerals and is therefore likely to be present chiefly as free gold. This is somewhat supported by the very high recoveries encountered in current metallurgical testwork.

The general paragenesis consists of (early to late) quartz veins – quartz, albite, biotite, muscovite, carbonate, epidote, sulphides – gold (and silver) as in-fills of veins and minor breccia zones – muscovite veins and alteration – pyrite veins (minor) – late quartz veins – and finally quartz, albite, biotite, muscovite, carbonate, epidote, sulphides and gold (and silver).

4.4 JULY 2014 SITE VISIT

Snowden's Principal Consultant, John Graindorge, visited the Tulu Kapi site on 19 July 2014 to 22 July 2014. At the time of the site visit, no drilling, sampling or sample preparation activities were taking place. Discussions were held with various KEFI personnel, most of whom were present during the previous drilling programmes including those conducted by Nyota. All aspects of the sample collection, sample preparation, QA/QC and assaying were reviewed with the site personnel. Additionally, the general site geology was assessed from diamond drill core and the available outcrop, including altered syenite and mineralised quartz veins.

The following items were reviewed during the site visit:

- General site geology from outcrop and diamond drill core
- RC and diamond core drilling procedures
- Drill hole collar and downhole surveying procedures
- RC and diamond core sampling procedures
- Surface trench sampling procedures for KEFI trenches
- Diamond drill core and RC chip tray storage facilities
- Geological logging procedures
- On-site laboratory sample preparation procedures
- QA/QC procedures
- Bulk density measurement procedures.

4.5 DRILLING

The Tulu Kapi resource estimate was completed using drilling data supplied by KEFI and consisted of a mixture of diamond drill holes, RC drill holes and trench samples. The de-surveyed drilling data was first filtered to only include holes which were collared within the extents detailed in Table 4-1 to remove drilling data located outside the immediate Tulu Kapi deposit area.

Table 4-1: Drilling Extents

Location	Minimum (m)	Maximum (m)
Easting	780 317	781 050
Northing	1 004 283	1 005 687

The drilling data used in compiling the August 2014 and January 2015 estimate is summarised in Table 4-2.

Table 4-2: KEFI Drilling Data

Company	Years	Drilling Method	Number of Drill Holes	Metres Drilled
TREC, GPMC, Nyota, KEFI	1996 to 2014	Diamond	298	72 033
		RC	342	45 611
		Trench	82	1 094
Total			**722**	**118 738**

4.5.1 Drilling Database

KEFI use an SQL server with Datashed (front end) to store and manage the data. All the field data was either captured by hard copy and subsequently uploaded to a spreadsheet system, or captured electronically, checked for consistency, and added to the database with all original entered spreadsheets stored. The database was checked for input errors at different stages, from the field office to the head office in Addis Ababa. The master database is managed by a Geological Database/GIS Manager based at Tulu Kapi, with QC and sampling protocols coordinated by a quality control manager.

The drilling data was provided to Snowden as an Access database for review.

4.5.1.1 Treatment of Below Detection Limit Values

Negative grade values are used by laboratories to indicate the following:

- The grade concentration being analysed is below the detection limit of the analytical method being used.
- There is insufficient sample material to undertake an analysis.
- Missing or lost samples

There were no negative grade values in the database. Below detection limit values were recorded using several values between 0.0005 and 0.01. Negative values (-444) were recorded for missing and insufficient samples. These were removed from the database for the purposes of resource estimation, variography, statistics and the analysis of standards, duplicates and blanks for quality control.

4.5.1.2 Database Validation

Before any work was completed, Snowden carried out an independent validation of the database as part of preparing the data for estimation. The database checks undertaken revealed the following:

- The downhole sampling intervals were consistent with no overlapping sample intervals.
- The sample tables did not contain duplicate sample records.
- There were no missing or incomplete collar survey coordinates.
- There were no negative downhole sample ranges or grades.
- Assay values were within expected bounds.

No material issues were found with the database.

4.5.2 Local grid and Survey Methods

4.5.2.1 Local Grid

The local Tulu Kapi grid is WGS84-36N. This is the World Geodetic System 1984 grid and is zone 36N.

4.5.2.2 Topography

In 2012, a LiDAR survey of the Tulu Kapi area was commissioned covering some 52 km^2 (5 200 ha). Given the remote and rugged terrain in the area, this provides complete coverage of the project. This survey was completed by Fugro MAPS of United Arab Emirates (Fugro).

From observations, it is apparent that the drill hole collars do not match the LiDAR-generated digital terrain model. The average difference between the LiDAR survey and the collars is 2.7 m. For this resource estimate, the digital terrain model that was generated by the LiDAR survey has subsequently been lowered by 2.7 m to better fit the drill hole collars, which KEFI believes are more accurate than the LiDAR survey. There are still small discrepancies between the LiDAR-generated digital terrain model and the drill hole collars and it is recommended that a more accurate topographic survey be completed before the next resource estimate.

4.5.2.3 Drill Hole Collars and Trenches

Drill hole collar and trench coordinates are initially located using GPS. When drilling has been completed, the collar location is re-surveyed using a Total Station by a geological survey team from Addis Ababa.

4.5.2.4 Downhole Survey Methods

A downhole survey was carried out via an EZ Track survey system by Reflex with an initial survey carried out at 25 m and then a survey carried out at every 50 m from then on. Non-vertical diamond drill holes following TKBH_080 were oriented using Reflex ACT II and ACT III orientation instruments. Three consecutive runs which lined up within 10 degrees of one another were considered to be of high confidence orientation.

Snowden notes that the downhole surveying method employed can be impacted by magnetic interference from the rocks and potentially the drill string. It is recommended that KEFI survey some holes, especially deeper holes, using a non-magnetic method (e.g. gyroscopic survey) to assess the impact of any magnetic interference on the azimuth measurements.

4.6 GEOLOGICAL LOGGING AND SAMPLING

4.6.1 Logging Facilities

During the site visit in July 2014, Snowden undertook an inspection of the core yard. The logging and cutting facilities were found to be clean and well organised (see Figure 4-5), with abundant space for core preparation and logging.

Source: Snowden

Figure 4-5: Core Logging Facilities at Tulu Kapi

4.6.2 Logging and Sampling Practices

KEFI has a standard operating procedure for logging and sampling core, however, it is not well documented or controlled. Snowden recommends that KEFI put together official procedures under the KEFI letterhead.

Based on the provided documentation and the site visit, Snowden drew the following conclusions:

- Logging procedures for the collection of geological data including lithology, structure, texture, mineralisation, alteration type, colour, weathering intensity and sulphide occurrence are well defined and, in Snowden's opinion, of good quality.
- RMR and Q systems were logged for the geotechnical programmes for all diamond drilling from TKBH_080, excluding the 20 m × 20 m infill programme, and are, in Snowden's opinion, of good quality.
- For diamond drill core and RC drill chips, logging was carried out to determine mineralisation intervals based on alteration type, presence of quartz veining, and sulphide occurrence.
- Up to 2012, the primary data gathered in the field was recorded on paper logging sheets and subsequently transferred to an electronic Access master database by a trained database manager. Following 2012, electronic logging was carried out for geological and geotechnical logging.

4.6.3 Diamond drilling

Diamond drilling was carried out as outlined below:

- Prior to logging, the diamond drill core was orientated and placed into wooden core boxes where the hole ID and metre marks are recorded. Wooden core blocks were used to define the depth of the core runs. It was then taken to the core logging facility.
- The diamond drill core was logged for lithology, structure, texture, mineralisation, alteration type, colour, weathering intensity and sulphide occurrence.
- Logging was carried out to determine mineralisation intervals based on alteration type, presence of quartz veining and sulphide occurrence.
- The minimum sample interval was 0.3 m, with a maximum of 1 m in interpreted mineralised domains and a maximum of 2 m in interpreted waste domains.
- RMR and Q systems were logged for the geotechnical programmes.
- The core was photographed in the trays at the sample storage facility.
- The core was cut manually using a diamond saw and the half core was sampled.
- The half core that was not sampled is stored in locked, secure sheds for future reference.

4.6.4 Reverse circulation drilling

Reverse Circulation (RC) drilling was carried out as outlined below:

- RC drill chips were logged for lithology, alteration and mineralisation type, and a small sample from each metre was kept in plastic chip trays as a logging record in a locked secure shed.
- Logging was carried out to determine mineralisation intervals based on alteration type, presence of quartz veining and sulphide occurrence.
- Bulk RC samples were split using a three-tiered riffle splitter at the drill site if dry. Wet samples generated by Nyota were transported to the sample storage facility and split using a similar three-tiered riffle splitter, with water used to clean the splitter between each wet sample. KEFI altered this process and for wet samples, a 2 m to 3 m composite was generated by spearing from the bulk sample bag. A 250 g pulp duplicate, or a 3 kg duplicate was kept from all drilling and is stored in a locked secure shed for future reference.

For dry samples, the approach adopted by Nyota and KEFI should produce reasonably representative samples, assuming the samples are introduced into the splitter properly. However, for wet samples, Snowden recommends that KEFI use a cone splitter in future drilling programmes as the current practice of spearing is incorrectly delimited and likely introducing a high sampling error.

4.6.5 Trenching

Trenching, undertaken by KEFI/ KME was carried out as outlined below:

- Trenches were dug by hand down to the saprock and are up to 3 m deep.
- The trench walls were mapped for lithology, alteration and mineralisation type and were all photographed before being filled back in.
- Mapping was carried out to determine mineralisation intervals based on alteration type, presence of quartz veining and sulphide occurrence.
- Channel samples were collected from the base of the trench wall. In some cases, the trenches go over outcropping rock and channel samples were collected from the outcrop, rather than the trench wall, in these cases.
- The sample line was surveyed by differential GPS (DGPS) by a contract surveyor.
- Channel sampling was carried out using a geopick. A jack-hammer was used for hard saprock or outcropping rock. All sampling was supervised by a senior geologist.
- The minimum sample interval was 0.3 m with a maximum of 1 m in interpreted mineralised domains and a maximum of 2 m in interpreted waste domains.

4.7 SAMPLE PREPARATION AND ANALYSIS

4.7.1 Laboratory Facilities and Sample Preparation

Sample preparation was carried out on site by trained staff following industry standard procedures with the assistance of a professional laboratory manager to train and monitor performance. The on-site sample preparation facility was managed and supervised by ALS during Nyota's drilling programmes. During KEFI's drilling and trenching, the on-site sample preparation facility was managed by KEFI's geologists.

The on-site preparation facility (see Figure 4-6) consists of an electric drying oven, a single jaw crusher, and a LM5 pulveriser, and is capable of preparing 80 to 100 samples per eight-hour shift. The equipment was observed to be clean and in good condition. For Nyota's drilling programmes, on-site sample preparation was to a pulp, while for KEFI's drilling programmes, samples were only crushed at the on-site sample preparation facility.

Source: Snowden

Figure 4-6: Laboratory Facilities at Tulu Kapi

Samples were crushed to 70 % passing 2 mm. A crusher sizing analysis was conducted every 20 samples and the jaws of the crusher were adjusted if any failures occurred. The results of the crusher sizing were recorded in a book, which KEFI is in the process of entering into a spreadsheet for analysis. A brief review of the results suggests no issues with the laboratory or the sample preparation.

Samples were then sent to either the Al Amri laboratory in Jeddah Saudi Arabia or the ALS laboratory in Bucharest Romania for analysis. Previously samples had been sent to the ALS laboratory in Johannesburg, South Africa, for analysis. Analysis is by certified method Au-AA26 which consists of a 50 g fire assay with an AAS finish.

4.7.2 Sample recovery

Recording of core sample lengths against drill metres and RC drill chip samples against expected weight was well documented and the records are available in a verified database.

Diamond drill core sample lengths were measured and lengths recorded after logging in order to be able to determine core recovery. Core recovery averaged 95 % through all rock types and types of ground. Due to good recoveries, triple tubing was not used.

RC drill chip samples of 1 m were weighed and the weight recorded to determine whether the weight was within a satisfactory range compared to the expected 25 kg. The data recorded by KEFI has been entered as weights, while the data that was previously entered appears to have been recorded as a mixture of weights and percentage recovery. Only the data compiled by KEFI is considered reliable and has been used to comment upon a sample recovery of 85 % of RC samples weighed at or over 25 kg.

Sample recovery is good at Tulu Kapi due to the competent granitoid ground and relatively thin overburden and completely oxidized horizon. For diamond drilling, the PQ diameter was used for collaring holes to maximise recovery in the clay-rich ground. Also, water feed was turned down and downforce increased to prevent material from washing out of the inner tube.

4.8 QUALITY ASSURANCE AND QUALITY CONTROL

The analysis of the QA/QC data from Tulu Kapi has been completed by Snowden with information supplied in the form of an Access database and several Word documents outlining standard operating procedures.

Most of the standard operating procedures are from Nyota and need to be updated to reflect that KEFI is now the project manager and to ensure that a permanent record of QA procedures is available for referral.

4.8.1 Quality assurance

Whilst on site, Snowden reviewed the logging and sample preparation procedures and an inspection of the core yard was undertaken; no material issues were found. Snowden notes, however, that the procedures are not well documented and it is recommended that KEFI develop official procedures associated with drilling, sampling, sample preparation, assaying and QA/QC.

4.8.2 Quality control

KEFI regularly inserted Certified Reference Material (standards) and blanks during the drilling campaigns as well as the submission of duplicate samples. A total of four QA/QC samples were inserted into the sample stream for every twenty samples processed and included a blank (local Ambo sandstone), standard, crush duplicate and pulp duplicate. A blank sample was also processed after every sample through the jaw crusher in order to prevent contamination.

4.8.2.1 Standards

Standards are inserted into the sample batches to assess the analytical accuracy of the laboratory assays. Thirty-five standards have been used over the life of the project. The standards are listed in Table 4-3, along with the expected gold value and standard deviations. KEFI inserts standards into the sample batches at a nominal rate of one standard every twenty samples.

Table 4-3: Standard Sample Expected Values and Standard Deviation

Standard ID	Expected value (ppm)	Standard deviation (ppm)
54Pa	2.90	0.11
62c	8.79	0.21
G01	0.02	0.02
G300-6	4.94	0.20
G301-13	1.68	0.08
G301-3	1.96	0.08
G301-5	4.29	0.21
G302-2	2.50	0.14
G302-3	2.33	0.12
G302-5	1.66	0.08
G303-5	16.11	0.67
G305-4	4.18	0.15
G305-5	2.43	0.12
G305-7	9.59	0.33
G306-1	0.41	0.03
G306-3	8.66	0.33
G306-4	21.57	0.78
G307-5	4.87	0.18

Standard ID	Expected value (ppm)	Standard deviation (ppm)
G308-8	2.45	0.12
G398-2	0.50	0.04
G398-4	0.66	0.05
G900-2	1.48	0.06
G901-10	0.50	0.03
G901-6	21.20	0.91
G901-7	1.52	0.06
G904-6	0.36	0.03
G905-2	0.52	0.04
G906-3	3.30	0.14
G907-2	0.89	0.06
G907-3	2.88	0.11
G907-5	1.34	0.07
G910-10	0.97	0.04
G910-3	4.02	0.17
G910-7	0.51	0.03
G911-4	2.43	0.09

All of the standards are commercial standards sourced from Geostats Pty Ltd, except standards 54Pa and 62c, which were sourced from Ore Research and Exploration Pty Ltd.

A common error encountered with the standard results is the incorrect standard ID being assigned to a standard sample. To assess this, Snowden generated a single control chart with all of the standards plotted as a separate series (see Annexure 4-1). Obvious cases of mistaken identity were identified in this graph. Where possible, KEFI's staff reclassified the incorrect standard samples to ensure that the statistics were not impacted by these outliers. A total of 703 samples were reclassified and are listed in Annexure 4-1. Snowden recommends that KEFI correct the standard ID for obvious cases of incorrect labelling of standard samples.

Summary statistics for all standards are presented in Table 4-4. Control charts for all standards, are provided in Annexure 4-1. Several standards had very few results (< 9). Control charts were not generated for these standards; however, the results are tabulated at the end of Annexure 4-1.

Table 4-4: Standard Summary Statistics

Standard	Statistic							
	Expected Value (g/t)	No. of Assays	Mean (g/t)	Minimum (g/t)	Maximum (g/t)	Standard Deviation	% Outside Three Standard Deviation Limits	Difference of Mean to Expected (%)
54Pa	2.90	14	2.94	2.77	3.21	0.13	0.0	1.3
62c	8.79	22	8.83	8.27	9.38	0.39	0.0	0.5
G01	0.02	452	0.03	0.005	4.71	0.22	2.0	50.0
G300-6	4.94	6	3.95	0.01	4.96	1.78	33.3	-20.0
G301-13	1.68	26	1.65	0.12	1.87	0.32	3.8	-1.8
G301-3	1.96	187	1.92	1.21	2.22	0.13	6.4	-2.0
G301-5	4.29	127	4.20	3.53	4.93	0.26	3.1	-2.1
G302-2	2.50	532	2.49	0.33	3.04	0.20	2.3	-0.4
G302-3	2.33	527	2.31	1.79	2.84	0.16	2.3	-0.9
G302-5	1.66	1	1.66				0.0	0.0
G303-5	16.11	21	16.79	14.9	18.1	1.07	0.0	4.2
G305-4	4.18	134	4.21	3.42	4.74	6.11	5.2	0.7
G305-5	2.43	172	2.45	2.10	2.81	0.14	1.2	0.8
G305-7	9.59	295	9.66	5.96	13.00	0.61	5.1	0.7
G306-1	0.41	146	0.40	0.31	0.49	0.03	1.4	-2.4
G306-3	8.66	66	8.33	5.75	9.58	0.79	19.7	-3.8
G306-4	21.57	210	20.99	18.15	24.10	1.16	10.5	-1.3
G307-5	4.87	545	4.92	4.36	6.35	0.24	2.9	1.0
G308-8	2.45	109	2.43	2.08	2.75	0.14	1.8	-0.8
G398-2	0.50	1,428	0.49	0.16	4.19	0.11	1.2	-2.0
G398-4	0.66	106	0.66	0.51	1.35	0.09	1.9	0.0
G900-2	1.48	90	1.45	1.17	1.64	0.08	4.4	-2.0
G901-10	0.50	57	0.48	0.31	0.53	0.03	1.7	-4.0
G901-6	21.20	5	20.62	18.8	22.6	1.22	0.0	-2.7
G901-7	1.52	79	1.52	1.34	2.46	0.13	3.8	0.0
G904-6	0.36	235	0.33	0.02	0.50	0.05	8.9	-8.3
G905-2	0.52	97	0.52	0.39	0.61	0.04	1.0	0.0
G906-3	3.30	116	3.30	0.22	3.8	0.34	1.7	0.0
G907-2	0.89	17	1.01	0.87	1.12	0.08	29.4	13.5
G907-3	2.88	96	2.85	2.50	3.22	0.14	2.1	-1.0
G907-5	1.34	205	1.32	0.32	1.56	0.11	1.9	-1.5
G910-10	0.97	9	0.95	0.89	0.98	0.03	0.0	-2.1
G910-3	4.02	93	3.90	0.38	4.46	0.42	1.1	-3.0
G910-7	0.51	241	0.49	0.01	0.67	0.04	3.3	-3.9
G911-4	2.43	83	2.45	2.27	2.65	0.07	0.0	0.8

Approximately 3.1 % of the standard results are outside the three standard deviation control limits. The majority of these are probably from mislabelling of standards; therefore, it is recommended that KEFI undertake an audit of the standards and blanks to correct these errors.

The average of the assay results for each standard is generally within 5 % of the expected value. Those averages that lie outside of this range are generally standards that do not have many results therefore averages are not representative. As mentioned above, if an audit of the standards and blanks is completed, it is expected that the average error between the expected values and actual values will decrease when mislabelled standards and blanks are corrected.

Overall, Snowden believes that, whilst some results are outside the control limits, the standard results show that reasonable analytical accuracy is being achieved with no evidence of analytical bias. However, Snowden recommends that KEFI review any failures to determine whether the standard sample was incorrectly assigned to the wrong standard, in which case it should be corrected in the database.

4.8.2.2 Field Duplicates

There are only 138 field duplicates, all of which were collected in the latest 2014 RC drilling campaign. During the latest drilling campaign, field duplicates were inserted into the sample batches at a nominal rate of one duplicate sample every twenty samples, resulting in approximately 5 % of the samples being duplicated.

Summary statistics for the RC field duplicates are provided in Table 4-5. Log-scale scatterplots and Quantile-Quantile (QQ) plots, along with ranked half absolute relative difference (HARD) plots are presented in Annexure 4-1.

Despite the fact that only 138 field duplicates were taken, the statistics show that the field duplicate samples compare reasonably well with the original samples. This is confirmed by the QQ plots which show no evidence of bias. The scatterplots show that while some differences are evident between the pairs, the data is primarily centred about the 1:1 line. The ranked HARD plot shows that 90 % of the duplicate pairs have a difference of less than approximately 50 % (as measured by the HARD statistic). Snowden considers this an acceptable outcome given the small data set and the nature of the Tulu Kapi gold mineralisation.

Table 4-5: Summary Statistics – RC Field Duplicates

Statistic	Au	Duplicate Au	% Difference
Number of pairs	138	138	
Minimum	0.0025	0.0025	0.0
Lower quartile	0.005	0.007	40.0
Median	0.05	0.04	-20.0
Mean	0.60	0.61	1.6
Upper quartile	0.35	0.35	0.0

Statistic	Au	Duplicate Au	% Difference
Maximum	7.72	9.92	28.5
Coefficient of variation	2.30	2.40	4.3
Standard deviation	1.37	1.46	6.6
Correlation coefficient	0.93		

4.8.2.3 Coarse Crush Duplicates

There are 5 787 coarse crush duplicates which have been collected from all drill hole types: 2 879 are from diamond drill core and 2 908 are from RC drilling. The diamond drill core duplicates are taken from the same half core which is sampled, with the other half core returned to the core tray for later reference. Coarse crush duplicates are inserted into the sample batches at a nominal rate of one duplicate sample every 20 samples, resulting in approximately 5 % of samples being duplicated.

Summary statistics for diamond and RC coarse crush duplicates are provided in Table 4-6 and Table 4-7, respectively. Log-scale scatterplots and QQ plots, along with ranked HARD plots are presented in Annexure 4-1.

The statistics show that both the diamond and the RC coarse crush duplicates compare reasonably well with the original samples. This is confirmed by the QQ plots which show no evidence of bias. The scatterplots show that while some differences are evident between the pairs, the data is primarily centred about the 1:1 line. The ranked HARD plot shows that 90 % of the duplicate pairs have a difference of less than approximately 38 % for diamond and 51 % for RC (as measured by the HARD statistic). Snowden considers the diamond results acceptable given the nature of the Tulu Kapi gold mineralisation. RC results show relatively poor precision and Snowden recommends that the RC splitting process be reviewed.

Table 4-6: Summary Statistics – Diamond Drill Core Coarse Crush Duplicates

Statistic	Au	Duplicate Au	% Difference
Number of pairs	2 879	2 879	
Minimum	0.0005	0.0005	0.0
Lower quartile	0.005	0.005	0.0
Median	0.005	0.005	0.0
Mean	0.76	0.77	1.3
Upper quartile	0.13	0.13	0.0
Maximum	228.0	238.0	4.4
Coefficient of variation	7.32	7.38	0.8
Standard deviation	5.57	5.69	2.1
Correlation coefficient	0.96		

Table 4-7: Summary Statistics – RC Coarse Crush Duplicates

Statistic	Au	Duplicate Au	% Difference
Number of pairs	2 908	2 908	
Minimum	0.0010	0.0005	-50.0
Lower quartile	0.005	0.005	0.0
Median	0.010	0.005	-50.0
Mean	0.38	0.38	0.0
Upper quartile	0.04	0.04	0.0
Maximum	48.7	39.7	-18.5
Coefficient of variation	5.73	5.40	-5.8
Standard deviation	2.18	2.04	-6.4
Correlation coefficient	0.91		

4.8.2.4 Pulp Duplicates

There are 5 581 pulp duplicates which have been collected from all drill hole types: 2 842 are from diamond drill core and 2 739 are from RC drilling. Pulp duplicates are inserted into the sample batches at a nominal rate of one duplicate sample every 20 samples, resulting in approximately 5 % of samples being duplicated.

Summary statistics for the pulp duplicates are provided in Table 4-8 and Table 4-9. Log-scale scatterplots and QQ plots, along with ranked HARD plots are presented in Annexure 4-1.

The statistics show that the pulp duplicate samples compare reasonably well with the original samples. This is confirmed by the QQ plots which show no evidence of bias. The scatterplots show that while some differences are evident between the pairs, the data is primarily centred about the 1:1 line. The ranked HARD plot shows that 90 % of the duplicate pairs have a difference of less than approximately 28 % for diamond and 33 % for RC (as measured by the HARD statistic). This is considered a little high but Snowden considers this a reasonable outcome given the nature of the Tulu Kapi gold mineralisation, however, as with the coarse crush duplicates the RC samples show poorer precision and Snowden recommends that the splitting procedures be reviewed.

Table 4-8: Summary Statistics – Diamond Drill Core Pulp Duplicates

Statistic	Au	Duplicate Au	% Difference
Number of pairs	2 842	2 842	
Minimum	0.0005	0.0005	0.0
Lower quartile	0.005	0.005	0.0
Median	0.005	0.005	0.0
Mean	0.72	0.69	-4.2
Upper quartile	0.08	0.08	0.0
Maximum	217.0	212.0	-2.3
Coefficient of variation	7.32	7.39	1.0
Standard deviation	5.25	5.09	-3.0
Correlation coefficient	0.97		

Table 4-9: Summary Statistics – RC Pulp Duplicates

Statistic	Au	Duplicate Au	% Difference
Number of pairs	2 739	2 739	
Minimum	0.0005	0.0005	0.0
Lower quartile	0.005	0.005	0.0
Median	0.005	0.005	0.0
Mean	0.25	0.25	0.0
Upper quartile	0.03	0.03	0.0
Maximum	39.1	38.1	-2.6
Coefficient of variation	5.44	5.43	-0.2
Standard deviation	1.39	1.38	-0.7
Correlation coefficient	0.94		

4.8.2.5 Blanks

Blanks are inserted into the sample batches to assess contamination which may occur during sample preparation and assaying. KEFI informed Snowden that the material used for blanks is locally produced Ambo sandstone which is not certified and as such no certificates are available for the blank material. The blanks are inserted into the sample batches at a nominal rate of one blank every 20 samples.

Summary statistics for blanks samples are presented in Table 4-10.

Table 4-10: Summary Statistics – Blanks

Statistic	Value
Number of samples	6 682
Minimum	0.0005
Maximum	28.3
Mean	0.02
Median	0.0005
% > 0.005 ppm	19.0 %
% > 0.01 ppm	4.6 %
% > 0.1 ppm	0.8 %
% > 0.25 ppm	0.4 %
% > 0.5 ppm	0.2 %
% > 1 ppm	0.1 %

The control chart (see Figure 4-7) and statistics show that the majority of the blanks samples have a gold content of below 0.1 ppm Au, with only 0.8 % of the samples being above this level, and only 0.2 % of the blanks above 0.5 ppm Au. The results indicate that, while some blanks samples that show elevated gold content are probably mislabelled standards, the overall contamination during the sample preparation and assaying is reasonable and within acceptable tolerance intervals.

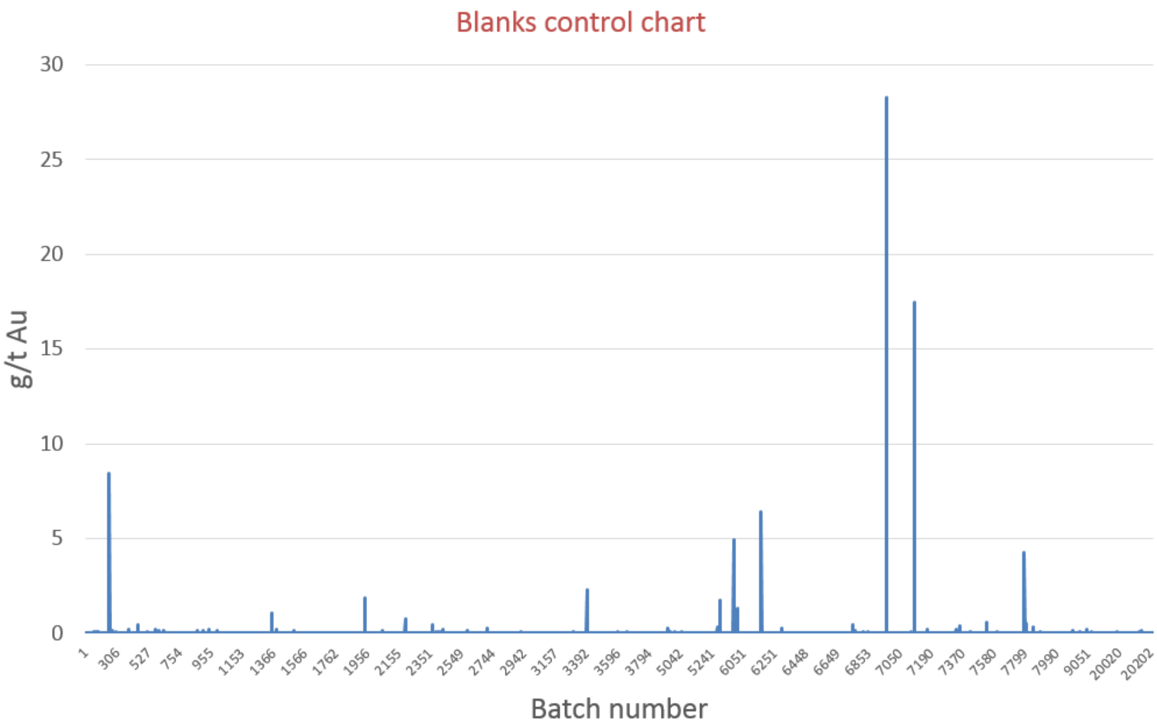


Figure 4-7: Blanks Control Chart

4.8.2.6 Check Assays – Umpire Laboratory

A batch of 374 check samples were assayed in 2012 at the SGS Perth laboratory, located in Western Australia, to compare against those assayed at the ALS laboratory in Johannesburg, South Africa. Snowden notes that the sample batches sent to SGS do not include any standards. It is recommended that standards be included in the check sample batches to assess the analytical accuracy of the check laboratory.

Summary statistics for the pulp check assay duplicates are provided in Table 4-11. Log-scale scatterplots and QQ plots, and ranked HARD plots, are presented in Annexure 4-1.

For gold, the statistics show that the pulp duplicate assays completed by SGS compare well with the original ALS assays, with the QQ plot showing no evidence of a systematic difference between the two laboratories. The scatterplot for gold shows that, while some differences are evident between the pairs, the data is generally centred about the 1:1 line. There does appear to be a small bias with several of the higher original assays having low umpire assay results but overall the results are acceptable.

The ranked HARD plot indicates that 90 % of the duplicate pairs have a difference of less than approximately 12 % (as measured by the HARD statistic). Snowden considers this to be a good level of precision for pulp duplicates.

Snowden recommends that check assays be sent to an umpire laboratory on a regular basis and that standards be included in the batches sent.

Table 4-11: Summary Statistics – Check Assay Duplicates (ALS vs SGS)

Statistic	Au (ALS)	Au (SGS)	% Difference
Number of pairs	374	374	
Minimum	0.08	0.01	-87.5
Lower quartile	0.61	0.61	0.0
Median	1.12	1.06	-5.4
Mean	2.65	2.68	1.1
Upper quartile	2.21	2.21	0.0
Maximum	86.50	101.00	16.8
Coefficient of variation	2.21	2.44	10.4
Standard deviation	5.88	6.52	-6.1
Correlation coefficient	0.75		

4.8.2.7 Laboratory Visits

Several inspections have been conducted by Saudi Arabian based senior KEFI management of Al Amri's Jeddah laboratory and found no areas of concern. Facilities at the laboratory were found to be clean, in good condition and up to industry standard.

No inspection of the ALS internationally accredited laboratory in Romania has been conducted.

4.8.3 Bias Testwork

Snowden carried out bias checks between the diamond and RC samples prior to estimation. A QQ plot was generated within the mineralised domains for an area with similar coverage of the two drill types. The QQ plot shows that there is no evidence of a bias (see Figure 4-8).

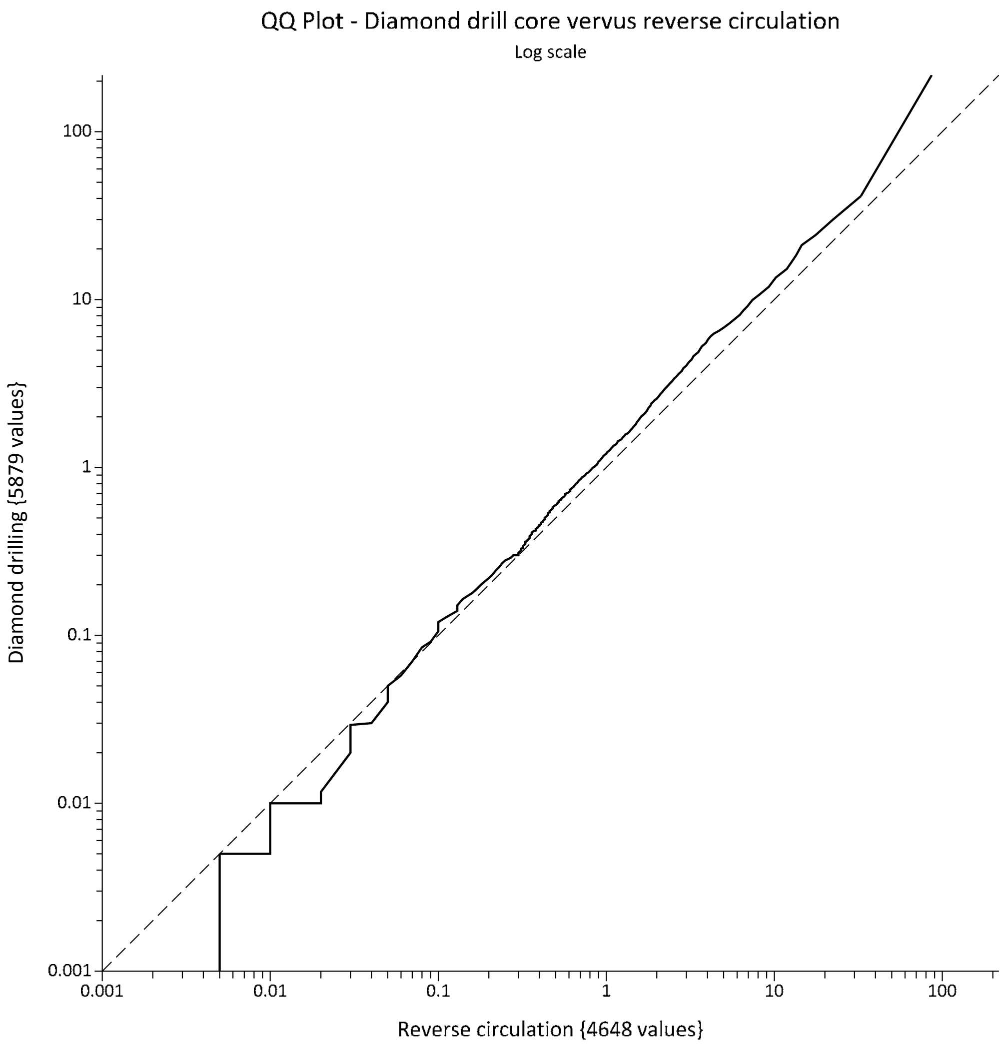


Figure 4-8: QQ Plot Comparing Diamond and RC Sampling

4.9 GEOLOGY AND GRADE ESTIMATION DOMAINS

The following sections describe the various domains defined for modelling and grade estimation purposes.

The geological and structural interpretation of the Tulu Kapi area has been based on surface mapping and drill hole interpretation and logging by a variety of consultants and qualified national staff working for the project since 2009. All data available has been used for the geological interpretation and is also available for review in digital or analogue format.

4.10 MINERALISATION DOMAINS

A complex structural environment and genesis exists with narrow shallowly dipping stacked veins which pinch and swell along strike and down dip. The relationships with grade, alteration, quartz veining and structure are not yet fully understood, however, structural geology interpretation and investigation is beginning to improve the understanding of the factors controlling grade continuity.

Mineralisation domains were determined using a nominal 0.3 g/t Au cut-off to create wireframes of the mineralised lodes which are orientated to the structural interpretation which dips around 30° to the northwest. A minimum width of 1 m was used for the interpretation. Mineralised domains were defined within the Central and UNDP (northern) areas of the deposit which are separated by faulting.

The 0.3 g/t Au cut-off was determined from a log-probability plot that showed a change in distribution at around 0.3 g/t Au to 0.4 g/t Au as shown by the red lines in Figure 4-9.

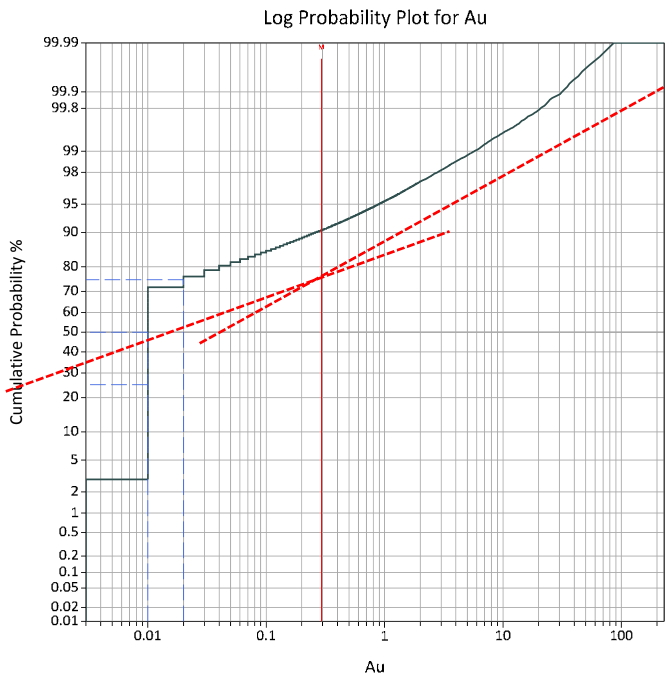


Figure 4-9: Log-Probability Plot of Global Gold Data Showing Change in Population

4.10.1 Rock Type Domains

To date, lithology domains have not been well defined, however, varied orientation of the dip and strike within the mineralised domains appears to be related to the lithology with steeper dips near the Bedele shear zone and shallower dips in the west and north. Domaining and analysing gold occurrence in the respective zones would further refine the domains.

For future updates, domains will be defined for the mafic dykes, altered and unaltered syenite, particularly the albite alteration zones closely associated with mineralisation and the footwall diorite. Interpretation work is ongoing and these domains will be finalised and outlined based on a final review of the interpretation and they will be used for subsequent resource updates.

4.10.2 Weathering Domains

The Tulu Kapi syenite hill is divided into two weathering zones: weathered and un-weathered. The transition zone between the two ranges from sub metre to several metres through the majority of the deposit. Previous hydrological work by WAI abandoned analysis of the transition zone due to its insignificant thickness. Further studies of the transition zone for both gold enrichment and density may assist in refining the estimation process.

The resource model includes a surface for the bottom of complete oxidation (BOCO), which is used to assign density to the weathered material and fresh material. Gold occurrence is not markedly different in weathered and fresh material and these domains were not separated for estimation. There is no supergene enrichment in Tulu Kapi.

4.11 RESOURCE ESTIMATION

4.11.1 Drill Hole Coding and Compositing

The samples were coded within the mineralised domain wireframes. Given the shallow oxidation profile, no separation was carried out by oxidation domain.

Due to the 1 m minimum width used for interpretation, there are some minor areas where the wireframes pass through the middle of a sample. This is due to larger samples in the hanging wall and footwall of the lodes. In order to correctly code a portion of the low grade into the lode composites, the samples were composited to 0.01 m prior to coding.

The coded data was subsequently composited to the dominant sample length of 1 m prior to analysis and estimation, using the mineralisation domains as hard boundaries. The composite lengths were adjusted to include all intervals and avoid the loss of residual samples (MODE=1 option in Datamine).

4.11.2 Drill Hole Statistics

Statistical analysis for gold was carried out on the composited data set within the mineralised domains for the Central and UNDP areas. The composites were reviewed to determine whether any bias exists due to clustering of the data. The results of the declustering analysis indicated that there was little impact and as a result no declustering has been applied to the statistics.

Both areas show positively skewed grade distributions with a high coefficient of variation (CV) ratio in the Central domain and a moderate CV in the UNDP domain. As a result, a top cut was applied to the Central domain to prevent overestimation and smearing of the comparatively high values into surrounding blocks. A top cut of 70 g/t Au was used, which impacted approximately 0.1 % of the grade population. No top cut was applied to the UNDP domain as no outliers occur in this area.

Table 4-12 summarises the statistics for the two areas within the mineralised domains. Log-probability plots and histograms are presented in Figure 4-10 and Figure 4-11 for the Central and UNDP areas respectively.

Table 4-12: Summary Statistics of Composited Data for Mineralised Domains

Statistic	Area	
	Central	UNDP
Samples	9 883	336
Minimum	0.00	0.01
Maximum	189.71	14.85
Mean	2.72	1.14
Standard deviation	6.44	1.58
CV	2.37	1.39
Variance	41.52	2.51
Skewness	9.72	4.39
Top cut	70	-
Number of samples cut	12	-
Top cut mean	2.67	-
Top cut standard deviation	5.69	-
Top cut CV	2.13	-
Top cut variance	32.41	-

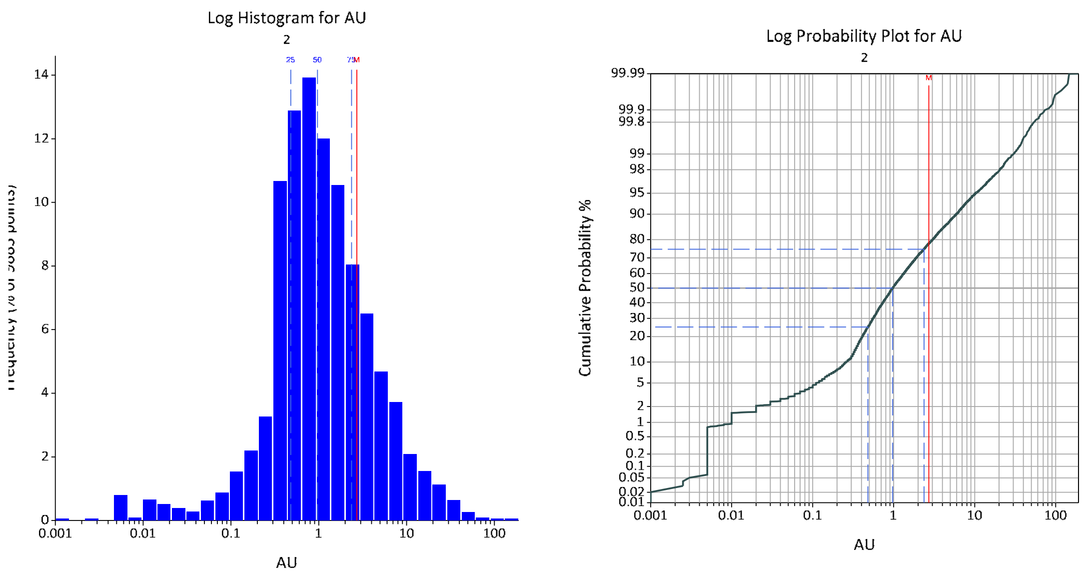


Figure 4-10: Log-Probability Plot and Histogram for Mineralised Domains – Central Area

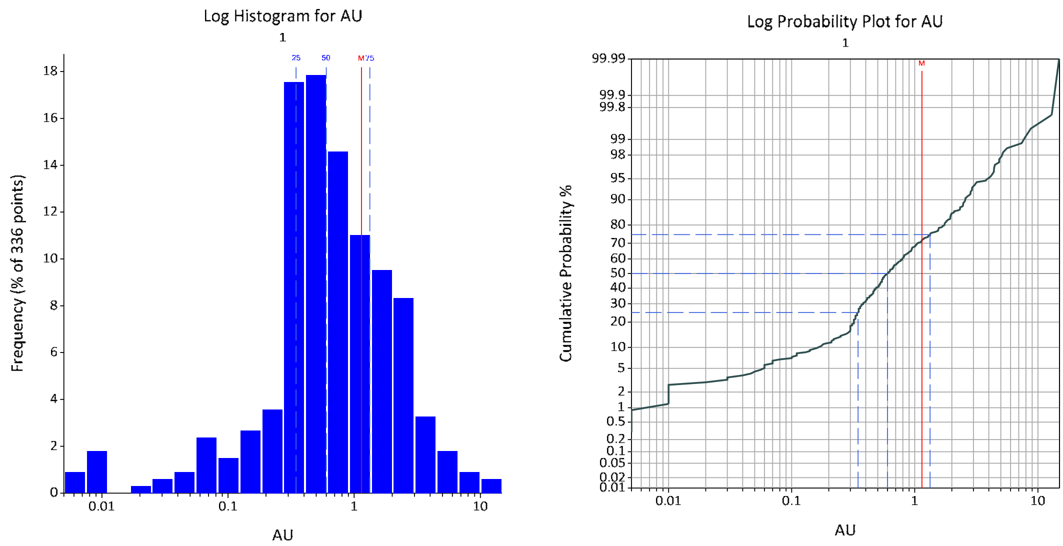


Figure 4-11: Log-Probability Plot and Histogram for Mineralised Domains – UNDP Area

4.11.3 Variography

Variograms were created and modelled using a normal scores transform for the Central area. The variogram model was back-transformed prior to estimation. The UNDP area contains insufficient data for variography and as such the variogram model for the Central area was also applied to the UNDP.

Table 4-13 summarises the back-transformed variogram models. Variogram models are illustrated in Figure 4-12. Note that it was not possible to get a well-structured downhole variogram due to the narrow nature of the lodes. The direction 1 variogram was used to infer the nugget. Due to the slight uncertainty on the nugget, sensitivity tests were run during estimation to assess the impact of a change in nugget (Section 4.12.4).

There are local changes in orientation and as a result, all estimation was carried out using dynamic anisotropy to orient the variograms based on the local orientation of the mineralisation.

Table 4-13: Back-Transformed Variogram Models for Gold – Central Area

Orientation	Nugget	Structure 1		Structure 2	
		Sill	Range	Sill	Range
00→010			15		38
-30→280	0.56	0.32	15	0.11	38
60→280			2		11

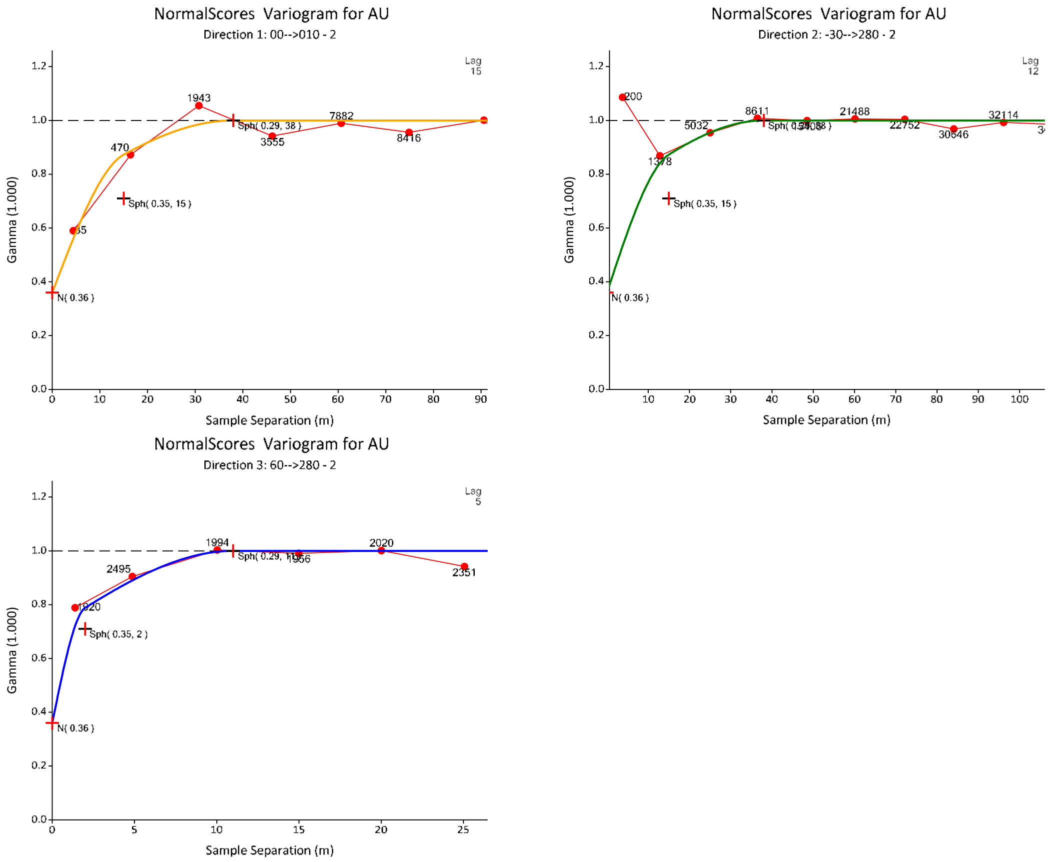


Figure 4-12: Variogram Models for Gold – Central Area

4.11.4 Kriging Neighbourhood Analysis

A kriging neighbourhood analysis was carried out to determine optimal block size and estimation parameters.

Test estimates were run using blocks sizes from 10 m × 10 m × 1 m up to 50 m × 50 m × 2 m in size. The kriging efficiency and slope of regression were calculated and plotted for each estimate (see Figure 4-13). Based on these results, together with practicalities around expected mining and the width of the mineralisation, a block size of 10 m × 10 m × 1 m was selected for estimation.

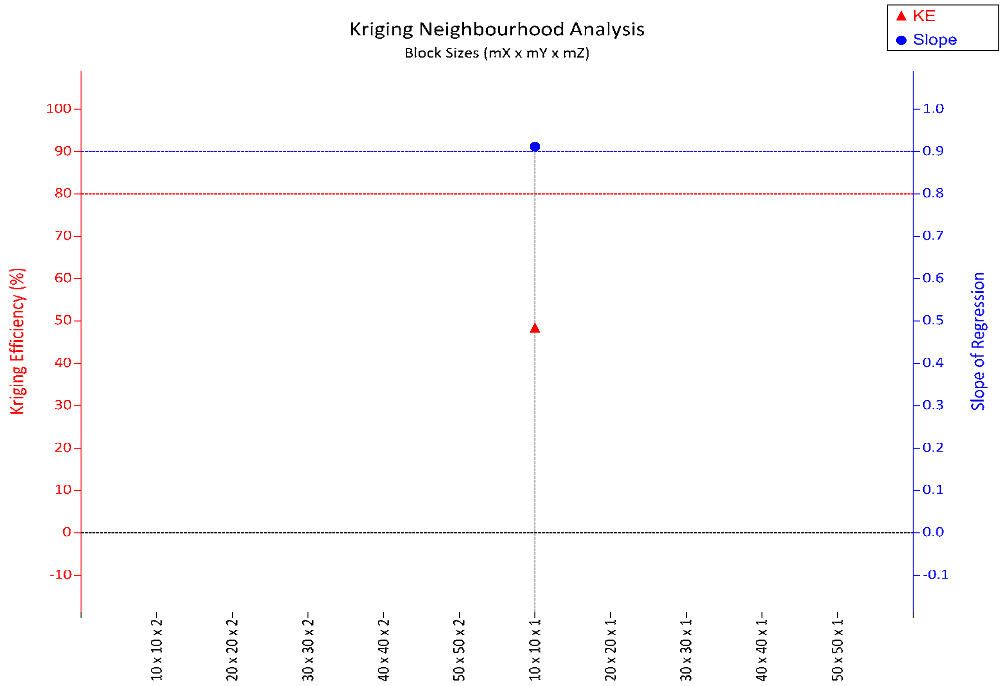


Figure 4-13: Kriging Efficiency and Slope of Regression for Central Area – Block Size

Further tests were run to assess the impact of the number of informing samples. The results indicated that a minimum of 8 and a maximum of 24 samples were suitable for estimation (see Figure 4-14).

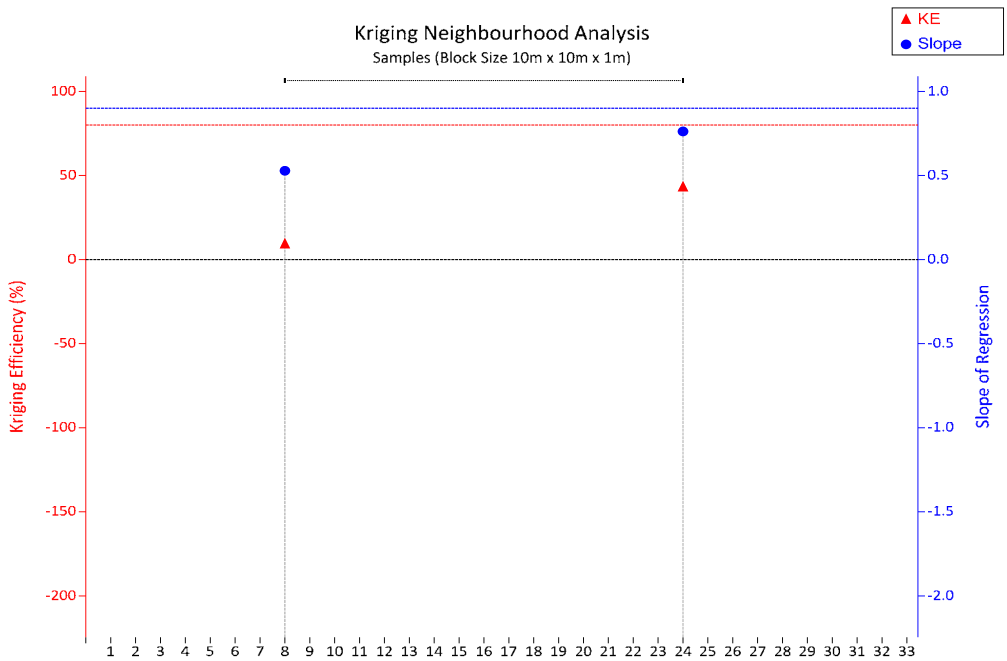


Figure 4-14: Kriging Efficiency and Slope of Regression for Central Area – Informing Samples

4.11.5 Block Modelling

A CAE Studio (Datamine) block model with cell dimensions of 10 mE × 10 mN × 1 mRL was coded to reflect the surface topography and the mineralisation domains. Block model dimensions are described in Table 4-14.

Table 4-14: Block Model Prototype

Block Model Field	Easting (X)	Northing (Y)	Elevation (Z)
Origin	779980	1003940	1100
Limit	781320	1005910	1800
Parent block size (m)	10	10	1
Number of blocks	134	197	700
Minimum sub-cell size (m)	2.5	2.5	0.5

4.11.6 Grade Estimation

A grade estimation was carried out in CAE Studio 3 (Datamine) using ordinary kriging with dynamic anisotropy to align the estimation with the local dip and strike of the mineralisation trends, into 10 mE × 10 mN × 1 mRL parent cells. Block discretisation was set to 4 × 4 × 2.

The estimation was performed on the mineralised and non-mineralised material defined within each domain (Central and UNDP).

The estimation was run in a three-pass kriging plan, the second and third passes using progressively larger search radii to enable the estimation of blocks that were not estimated on the previous pass. The search parameters were derived from the variogram analysis, with the first search distances corresponding to the distance at around half of the variogram sill value (20 m × 20 m × 5 m) and the second search distance approximating up to the variogram range (40 m × 40 m × 10 m). A third search was run to fill the low confidence areas of the estimate (80 m × 80 m × 20 m).

Blocks were estimated using a minimum of 8 with a maximum of 24 samples (minimum of 6 and a maximum of 24 for the second pass and minimum of 1 and a maximum of 20 for the third pass) and a maximum of 4 composites allowed per drill hole.

4.11.7 In-Situ Density

A global (dry) density value of 1.5 t/m^3 was used for all saprolite material. A global (dry) density value of 2.74 t/m^3 was used for all fresh material.

Density values for the fresh material have been derived from density measurements carried out by ROCKLAB, supplemented by additional density testing on site by Nyota. The measurements represent a dry density.

From field measurements (over 14 000 samples) the average density of the mafic syenite (mineralisation) is 2.741 t/m^3 and so the use of 2.74 t/m^3 is robust.

Saprolite density has been derived from limited work carried out by Nyota, testwork at ROCKLAB in 2011 and ALS laboratory Romania in 2014. In 2012, Nyota submitted 56 samples of saprolite material for analysis at Water Works and Supervision Enterprise Laboratory Service Sub Process, Addis Ababa, Ethiopia. The results of this testwork recorded an average bulk density of 1.86 t/m^3 and a dry density of 1.47 t/m^3. In 2014, KEFI submitted 27 saprolite samples to ALS laboratory in Romania for analysis; these had an average dry density of 1.57 t/m^3. This gives an overall average dry density of 1.5 t/m^3 for the 83 samples.

4.11.8 Model File

Table 4-15 describes the fields in the final model, tk1501.dm.

Table 4-15: Final Model Fields

Field	Value	Description
OXSTATE (ore zone)	1	Saprolite rock
	2	Fresh rock
FZONE (fault zone)	1	UNDP
	2	Central
DENSITY	1.50	Oxide material
	2.74	Fresh material
LITH (lithological descriptor)	10	Footwall
	20	Eastern diorite
	30	Syenite
	40	Northern dyke swarm
	50	Southern dyke swarm
RESCAT (resource category)	0	Unclassified
	2	Indicated
	3	Inferred
TRDIPDIR		Dynamic anisotropy – true dip direction
TRDIP		Dynamic anisotropy – True dip angle
NSAMAU		Number of samples – Au estimate
SVOLAU		Search volume – Au estimate
TDISAU		Transition distance – Au estimate

Field	Value	Description
VARAU		Variance – Au estimate
AU		Gold grade (g/t Au)
AU2, AU3		Gold grade (g/t Au) – sensitivity test runs
LODE	1-600	Individual numbering for each lode
AREA	WAST	Background
	CENT UNDP	Central domain lodes UNDP domain lodes
NDIP		Number of samples for estimation – true dip
NDIPDIR		Number of samples for estimation – true dip direction
TRPLUNGE		Dynamic anisotropy – true plunge direction

4.12 MODEL VALIDATION

In addition to conducting validation checks on all stages of the modelling and estimation process, final grade estimates and models were validated by

- undertaking global grade comparisons with the input drill hole composites
- visual validation of block model cross sections
- grade trend plots

No obvious interpolation issues were identified and there is no evidence of significant over or under-estimation apparent in the model.

4.12.1 Global Comparisons

The final grade estimates were validated statistically against the input drill hole composites. Table 4-16 provides a comparison of the estimated grades compared to the input grades for the global estimates within the mineralised domains within the Central and UNDP areas. This statistical comparison shows that the domains validate reasonably well globally.

Table 4-16: Comparison of the Mean Composite Grade with the Mean Block Model Grade for the Mineralised Domains

Description	Mineralised Domain	
	Central (Au g/t)	UNDP (Au g/t)
Number of samples	9 883	336
Composite mean	2.72	1.14
Estimated mean	2.71	1.10

4.12.2 Visual Validation

A visual comparison of the composite sample grade and block grade was conducted in cross section and in plan. Visually the model was considered to spatially reflect the composite grades as shown in Figure 4-15 below within the mineralised lodes.

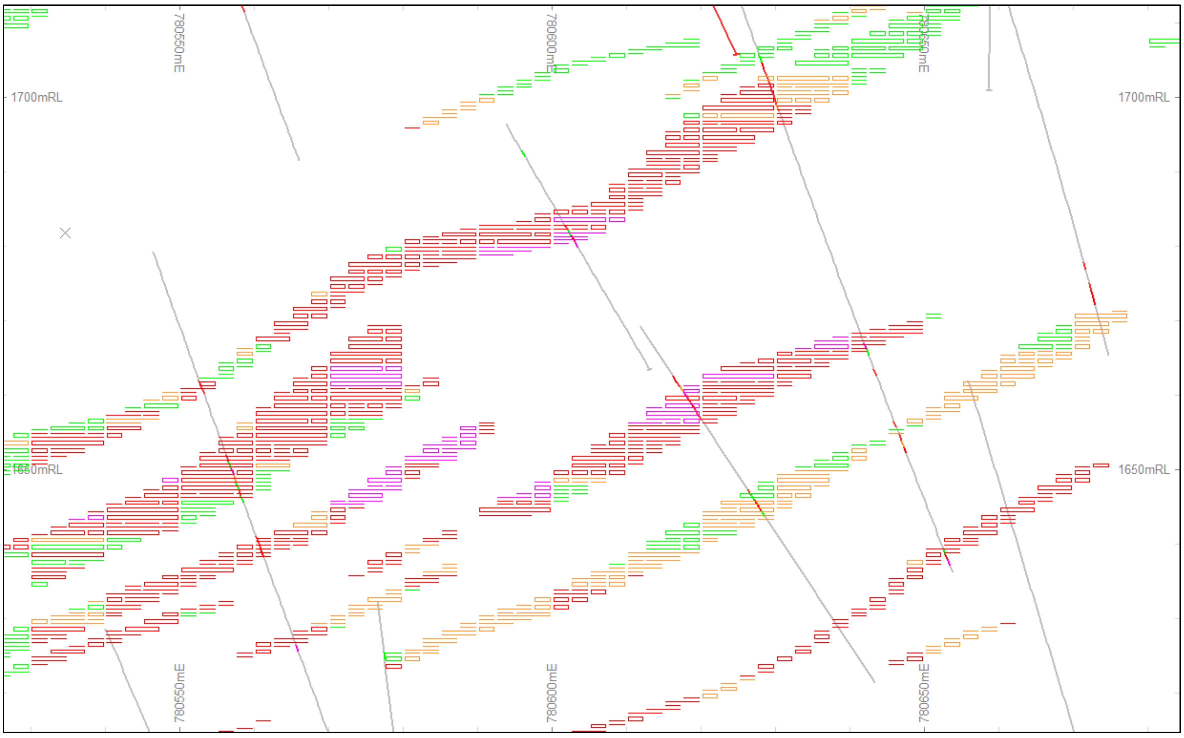
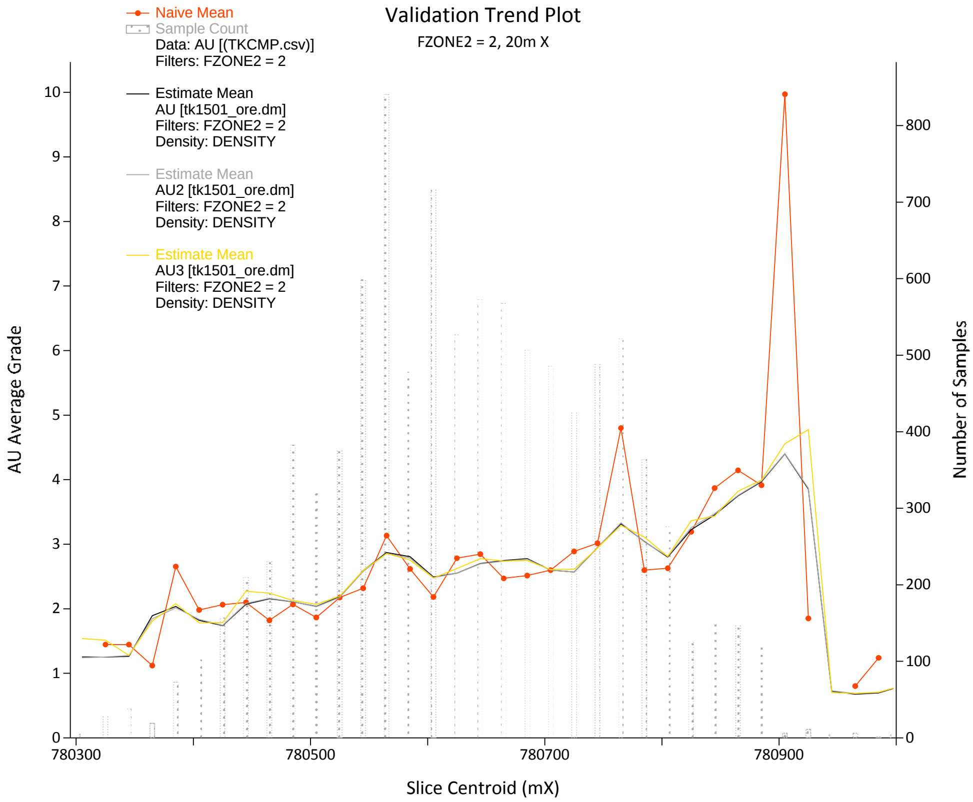


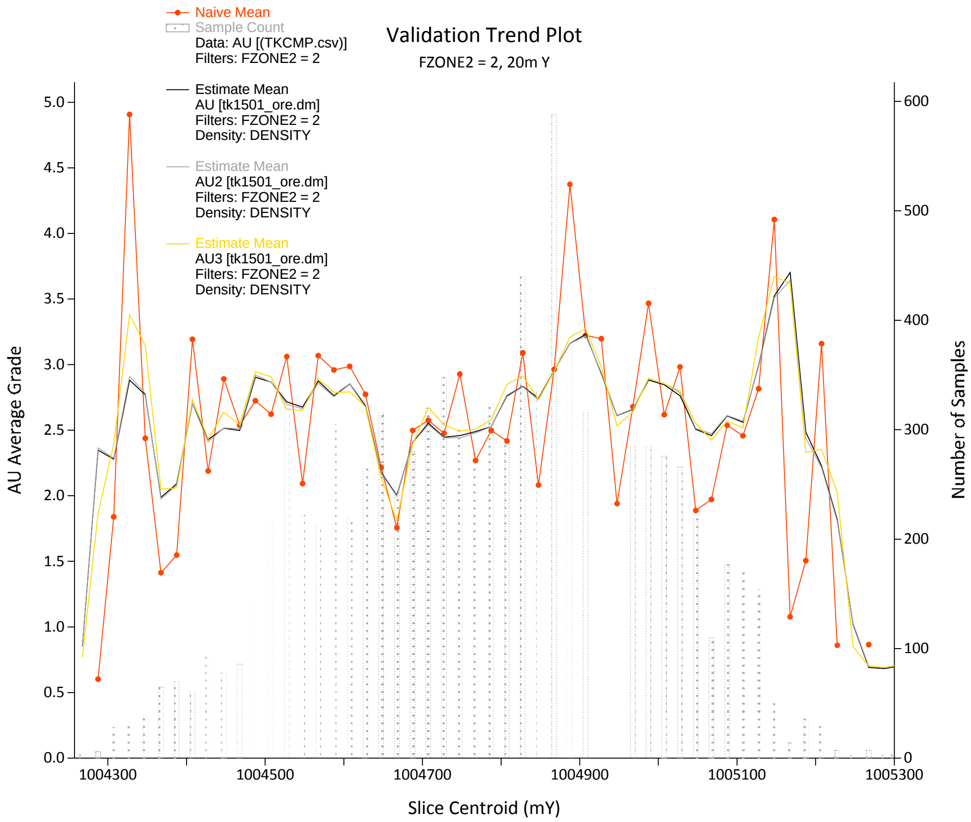
Figure 4-15: Visual Validation Cross Section 1 004 750 mN ± 25 m Clipping

4.12.3 Grade Trend Plots

Sectional validation graphs were created to assess the reproduction of local means and to validate the grade trends in the model for the Central and UNDP areas (see Figure 4-16 and Figure 4-17). These graphs compare the mean of the estimated grades to the mean of the input grades within model slices (bins). The final estimate (AU) is shown together with the sensitivity estimates (runs 2 and 3, Section 4.12.4). The graphs also show the number of input samples on the right axis, to give an indication of the support for each bin.

The graphs indicate that there is good local reproduction of the input grades in both the horizontal and vertical directions. The sensitivity estimates show similar results to the main estimate, with slightly increased selectivity in run 3 as discussed in Section 4.12.4.


Naive Mean
Sample Count
Data: AU [(TKCMP.csv)]
Filters: FZONE2 = 2
Validation Trend Plot
FZONE2 = 2, 20m X
Estimate Mean
AU [tk1501_ore.dm]
Filters: FZONE2 = 2
Density: DENSITY
Estimate Mean
AU2 [tk1501_ore.dm]
Filters: FZONE2 = 2
Density: DENSITY
Estimate Mean
AU3 [tk1501_ore.dm]
Filters: FZONE2 = 2
Density: DENSITY
AU Average Grade
Number of Samples
Slice Centroid (mX)
780300
780500
780700
780900


Naive Mean
Sample Count
Data: AU [(TKCMP.csv)]
Filters: FZONE2 = 2
Validation Trend Plot
FZONE2 = 2, 20m Y
Estimate Mean
AU [tk1501_ore.dm]
Filters: FZONE2 = 2
Density: DENSITY
Estimate Mean
AU2 [tk1501_ore.dm]
Filters: FZONE2 = 2
Density: DENSITY
Estimate Mean
AU3 [tk1501_ore.dm]
Filters: FZONE2 = 2
Density: DENSITY
AU Average Grade
Number of Samples
Slice Centroid (mY)
1004300
1004500
1004700
1004900
1005100
1005300

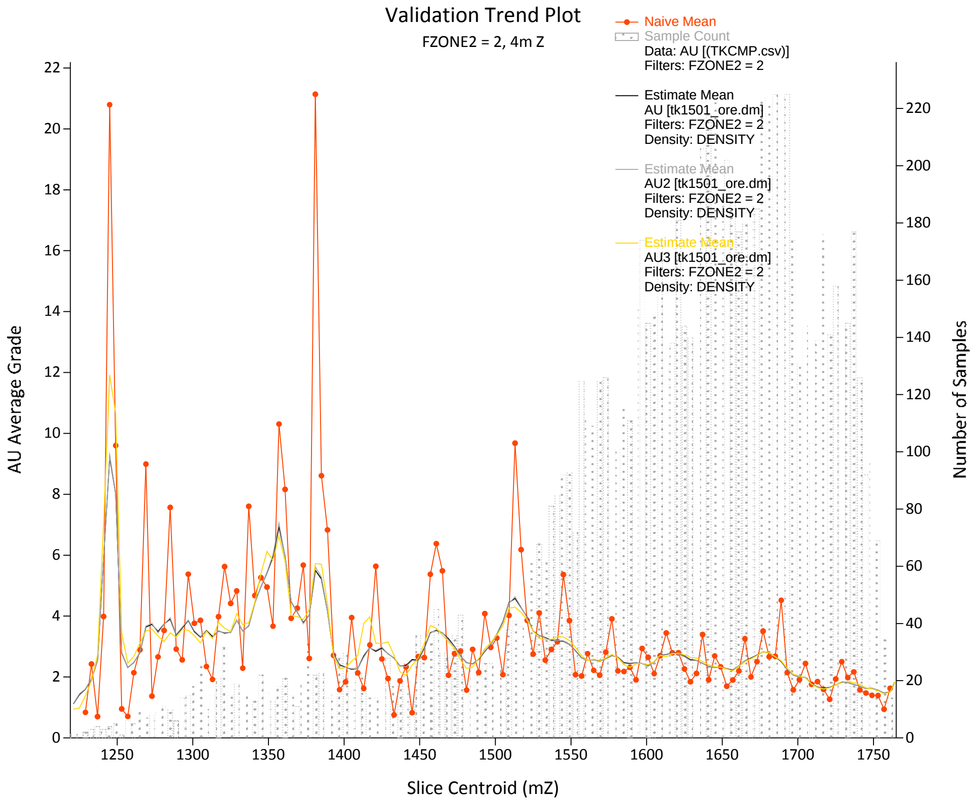
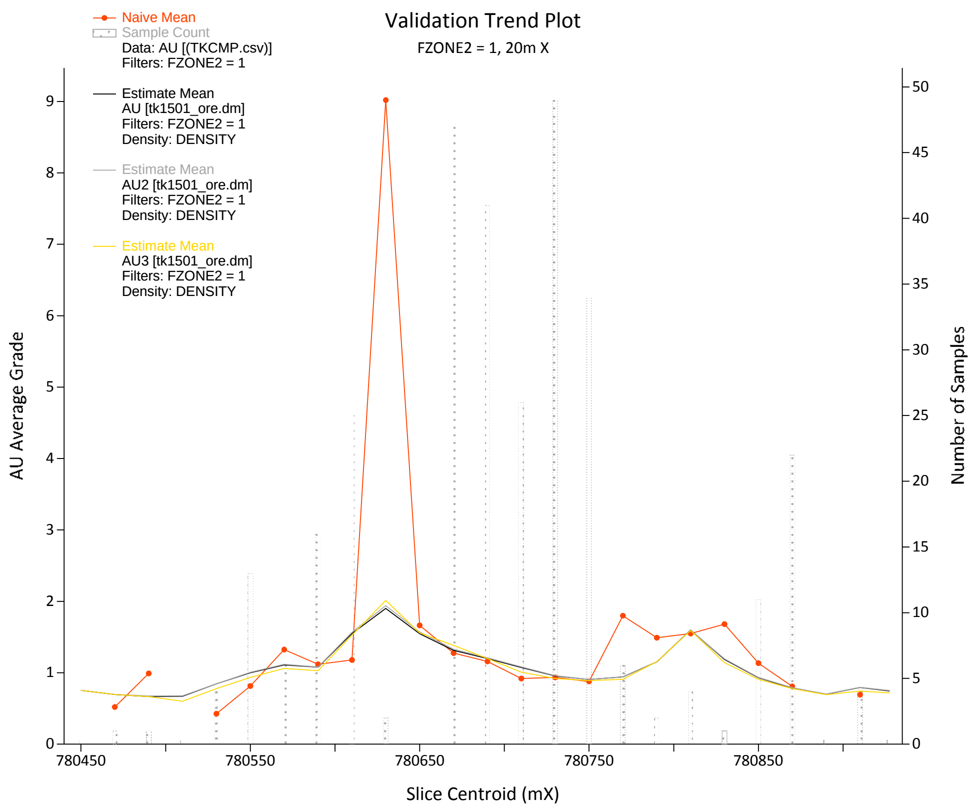
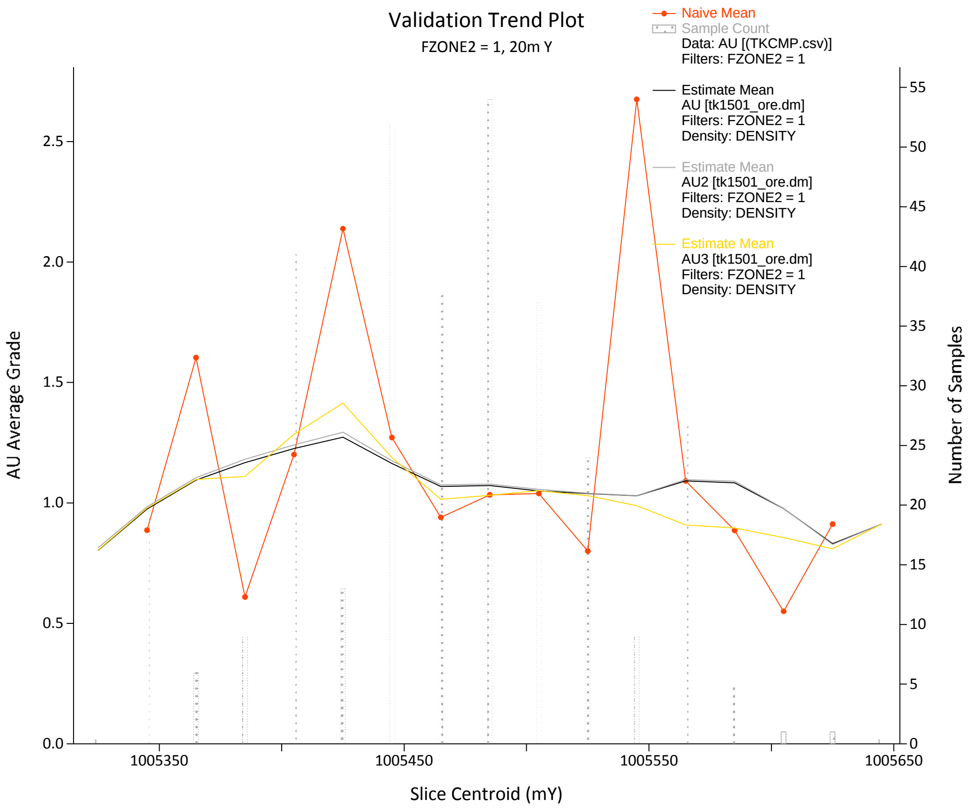


Figure 4-16: Grade Trend Plots for Gold – Central Area





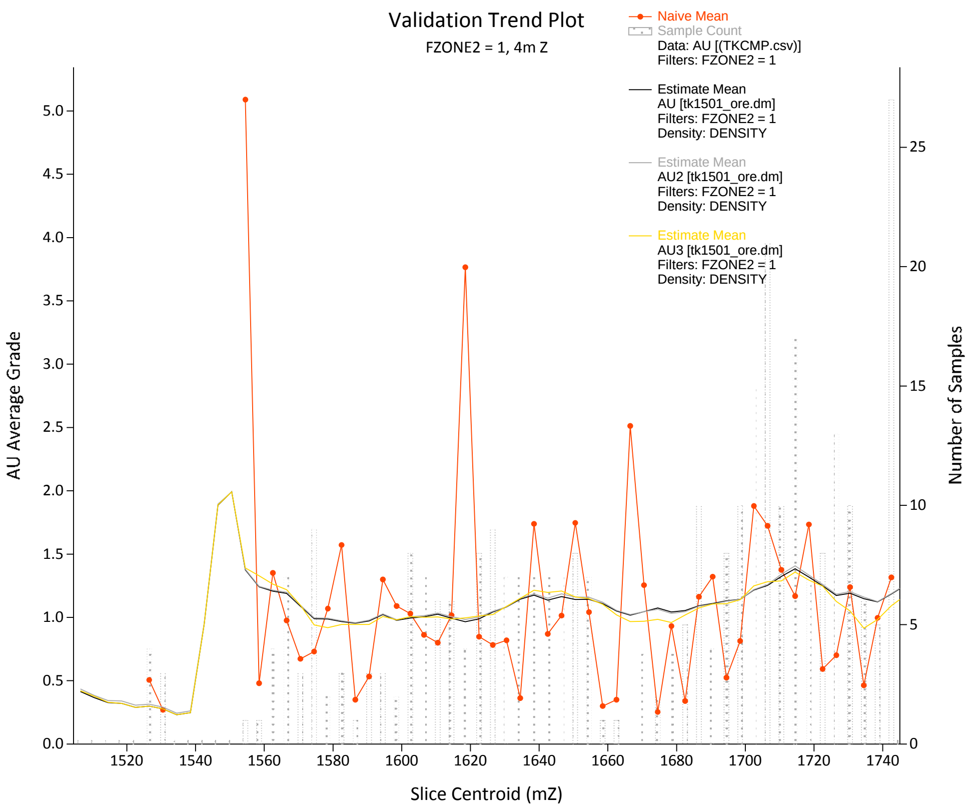


Figure 4-17: Grade Trend Plots for Gold – UNDP Area

4.12.4 Sensitivity Testing

In order to test the sensitivity of the grade estimate to the estimation parameters, Snowden ran a series of estimates and compared the results. Estimates were run as follows:

- Run 1: Main estimation using January 2015 parameters (AU)
- Run 2: Testing the impact of the nugget by using a lower nugget (0.37) derived from initial broader wireframes created during October 2014 (AU2)
- Run 3: Testing the impact of the search by using the August 2014 samples numbers 6 to 24 for pass 1, 3 to 24 for pass 2, and 1 to 20 for pass 3 (AU3)

The resultant estimates were plotted on grade trend plots to compare the local grade variability to the input data (see Figure 4-16 and Figure 4-17). The results show that there is little impact as a result of the change in nugget. The reduced number of samples in the search results in slightly more selectivity.

In addition, grade tonnage curves were generated for each estimate (see Figure 4-18). These highlight the similarity between run 1 and run 2, and the increased selectivity in run 3.

As a result, Snowden confirms that there is little risk in the higher nugget used for this estimate. The revised search parameters are considered appropriate, however, they cause some additional smoothing compared to the previous estimate.

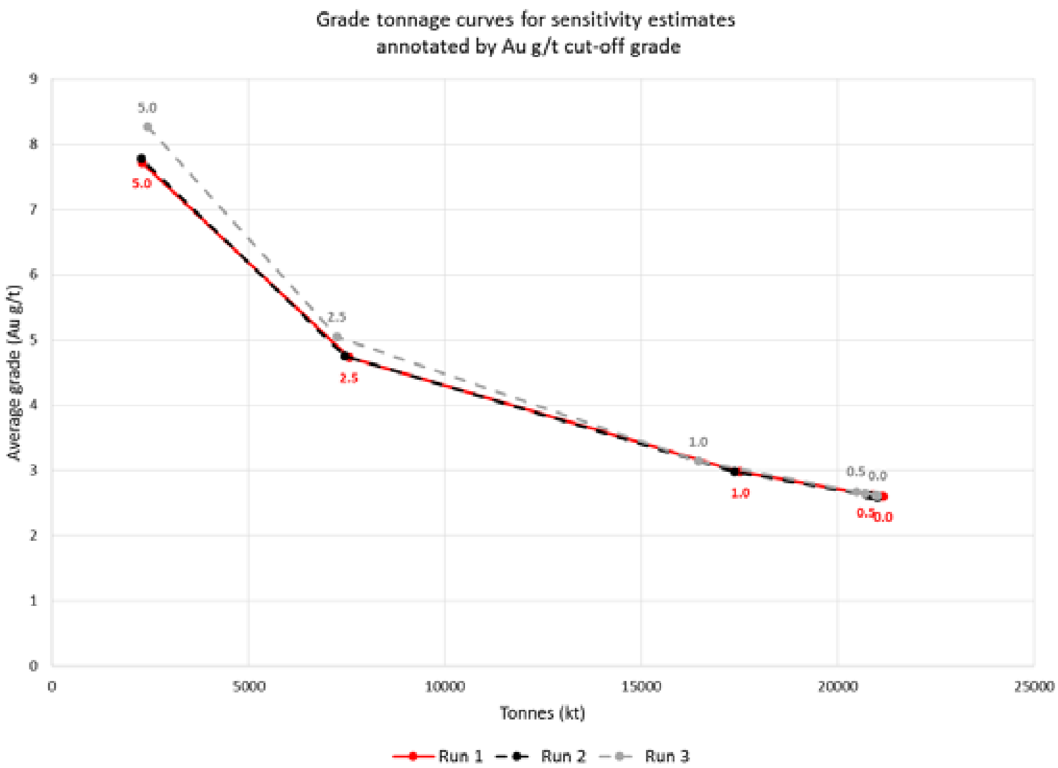


Figure 4-18: Grade Tonnage Curves for Sensitivity Estimates

4.13 MINERAL RESOURCE CLASSIFICATION

Table 4-17, Table 4-18 and Table 4-19 list Snowden and KEFI's assessment of the criteria that were considered when classifying the August 2014 Tulu Kapi resource estimate in accordance with the JORC Code (2012).

4.13.1 JORC 2012 Guidelines

Table 4-17: Section 1 Sampling Techniques and Data

(Criteria in this Section apply to all succeeding Sections.)

Criteria	JORC Code Explanation	Commentary
Sampling techniques	• *Nature and quality of sampling (e.g. cut channels, random chips, or specific specialised industry standard measurement tools appropriate to the minerals under investigation, such as downhole gamma sondes, or handheld XRF instruments, etc.). These examples should not be taken as limiting the broad meaning of sampling.* • *Include reference to measures taken to ensure sample representivity and the appropriate calibration of any measurement tools or systems used.* • *Aspects of the determination of mineralisation that are Material to the Public Report. In cases where 'industry standard' work has been done this would be relatively simple (e.g. 'reverse circulation drilling was used to obtain 1 m samples from which 3 kg was pulverised to produce a 30 g charge for fire assay'). In other cases more explanation may be required, such as where there is coarse gold that has inherent sampling problems. Unusual commodities or mineralisation types (e.g. submarine nodules) may warrant disclosure of detailed information.*	• Diamond drill core, after delivery to a dedicated core yard, core was photographed and sample intervals were marked by a geologist and the core was split using Clipper diamond core saws. Core recovery and RQD were measured at the diamond drill site right out of the inner tube using trained technicians. Half core samples were submitted to the on-site preparation facility for drying, crushing and pulverising. The samples were typically taken at 1 m intervals in expected mineralisation and 2 m intervals in expected waste except where the samples crossed lithological boundaries. In this instance, the samples were terminated at the lithological contact. All samples taken were greater than 30 cm in length. Sampling of diamond core followed industry standard procedures. • RC drill samples were sampled every metre and were bagged and riffle split at the drill hole if they were dry and a sample of approximately 3 kg was kept for sample preparation. RC samples were submitted to the on-site preparation facility for drying, crushing and pulverising. Sampling of dry RC chips followed industry standard procedures. • Wet RC samples were taken in their entirety to the sample storage facility and riffle split with a clean water wash between splits. Wet RC samples were submitted to the on-site preparation facility for drying, crushing and pulverising. Splitting of wet RC samples is not ideal, however, care was taken to ensure riffle splitters were kept clean and sample quality was considered to be acceptable. • Trench samples were collected from trenches that were dug by hand and up to 3 m deep. Samples were collected under the supervision of the senior geologist from the base of the trench using either a geologist's pick or a jack-hammer in the harder rock. Samples were taken at 1 m intervals except where lithological boundaries were crossed and the minimum sample length is 0.3 m. • Appropriate care was taken by supervising geologists at the drill hole and at the sample storage facility to process both diamond core and RC chip samples. Lithologies were respected as boundaries for sampling where a mineralised lithological unit was greater than 0.3 m drilled thickness.

Criteria	JORC Code Explanation	Commentary
		• Both diamond drill core and RC chips samples were sample prepped and assayed via an industry standard procedure. Sample prep was carried out on site and the resulting 100 g pulp assayed by fire assay using a 50 g charge and AAS finish.
Drilling techniques	• *Drill type (e.g. core, reverse circulation, open-hole hammer, rotary air blast, auger, Bangka, sonic, etc.) and details (e.g. core diameter, triple or standard tube, depth of diamond tails, face-sampling bit or other type, whether core is oriented and if so, by what method, etc.).*	• Diamond drilling was carried out with typically three core diameters, PQ (85 mm) in saprolite and through the saprolite to the fresh/transitional boundary, HQ (63 mm) to a depth of 100 m and NQ (47 mm) to depths beyond 100 m. All diamond core was orientated. Downhole survey was carried out via an EZ Track survey system by Reflex with an initial survey carried out at 25 m and then a survey carried out at every 50 m from then on. Non-vertical diamond drill holes following TKBH_080 were oriented using Reflex ACT II and ACT III orientation instruments. Three consecutive runs which lined up within 10 degrees of one another were considered to be of high confidence orientation. • RC drilling was carried out with a face sampling hammer and 8 inch bit in the saprolite layer reducing to a 3 ½ inch bit in the fresh material. RC holes were surveyed using the Reflex EZ Track inside 6 m of stainless steel rods which immediately followed the hammer. Survey frequency was every 50 m. • 722 drill holes and trenches totalling 118 738.3 m were used in the preparation of the resource estimate including - 298 diamond drill holes (NQ, HQ and PQ diameter) for 72 032.9 m - 342 RC drill holes for 45 611 m - 82 trenches for 1 094.4 m
Drill sample recovery	• *Method of recording and assessing core and chip sample recoveries and results assessed.* • *Measures taken to maximise sample recovery and ensure representative nature of the samples.* • *Whether a relationship exists between sample recovery and grade and whether sample bias may have occurred due to preferential loss/gain of fine/coarse material.*	• Diamond drill core sample lengths were measured and lengths recoded after logging in order to be able to determine core recovery. Core recovery averaged 95 % through all rock types and types of ground. Due to good recoveries, triple tubing was not used. • KEFI's RC drill chip samples of 1 m were weighed and weight recorded to determine if weight was within a satisfactory range compared to the expected 25 kg. Previous operators also recorded sample recovery by percentage or weight for 58 % of RC holes. • Recording of core sample lengths against drill metres and RC drill chip samples against expected weight was well documented and records available in a verified database. • Sample recovery is good at Tulu Kapi due to the competent granitoid ground and relatively thin

Criteria	JORC Code Explanation	Commentary
		overburden and completely oxidized horizon. For diamond drilling, PQ diameter was used for collaring holes to maximise recovery in the clay rich ground. Also, water feed was turned down and down force increased to prevent material from washing out of the inner tube. • Drilling of RC samples below the water table showed a variability in sample weights for wet samples. Previous statistical studies during the definitive feasibility study suggested wet RC samples tended to underestimate gold grade compared to diamond drill samples below the water table.
Logging	• *Whether core and chip samples have been geologically and geotechnically logged to a level of detail to support appropriate Mineral Resource estimation, mining studies and metallurgical studies.* • *Whether logging is qualitative or quantitative in nature. Core (or costean, channel, etc.) photography.* • *The total length and percentage of the relevant intersections logged.*	• For diamond drill core and RC drill chips, logging was carried out to determine mineralisation intervals based on alteration type, presence of quartz veining and sulphide occurrence. • Diamond drill core was logged for lithology, structure, texture, mineralisation, alteration type, colour and weathering intensity and sulphide occurrence. RMR and Q systems were logged for the geotechnical programmes for all diamond drilling from TKBH_080, excluding the 20 m × 20 m infill programme. Core was photographed in the trays at the sample storage facility. The half core not sampled is stored in a locked secure shed for future reference. • RC drill chips were logged for lithology, alteration and mineralisation type and a small sample kept from each metre in plastic chip trays as a logging record in a locked secure shed • Trenches were logged for lithology, alteration and mineralisation type and were all photographed before being filled back in. • Up to 2012, primary data gathered in the field was recorded on paper logging sheets which were then transferred to an electronic Access master database via a trained database manager. Following 2012, electronic logging was carried out for geological and geotechnical logging. • All sample intervals returned from drilling activities were logged.
Sub-sampling techniques and sample preparation	• *If core, whether cut or sawn and whether quarter, half or all core taken.* • *If non-core, whether riffled, tube sampled, rotary split, etc. and whether sampled wet or dry.* • *For all sample types, the nature, quality and appropriateness of the sample preparation technique.*	• Core was sawn with Clipper core saws and half was taken for sample preparation and assay. • RC chips were riffle sampled at the drill site if dry and riffle sampled at the sample storage facility if wet. • Sample sizes are industry standard for the type of rock and mineralisation being sampled. • Sample preparation was carried out on-site by trained staff following industry standard procedure with the assistance of a professional laboratory manager to train and monitor performance.

Criteria	JORC Code Explanation	Commentary
	• *Quality control procedures adopted for all sub-sampling stages to maximise representivity of samples.* • *Measures taken to ensure that the sampling is representative of the in-situ material collected, including for instance results for field duplicate/second-half sampling.* • *Whether sample sizes are appropriate to the grain size of the material being sampled.*	• A total of four QA/QC samples were inserted into the sample stream for every 20 samples processed and included a blank (local Ambo sandstone), standard, crush duplicate and pulp duplicate. A blank sample was also processed after every sample through the jaw crusher and pulveriser in order to prevent contamination. • The database is constructed so that automatic checks on the input data are carried out with both crushed and pulp duplicates plotted against the primary sample value. • Snowden reviewed the QA/QC results for standards, duplicates and blanks and considers the precision and accuracy acceptable for this style of deposit. • All diamond half core has been kept stored in a secure sample storage facility as has a 200 g to 250 g pulp duplicate (from the on-site sample preparation lab) from RC drill metres. Duplicate samples have not been processed but are available for processing.
Quality of assay data and laboratory tests	• *The nature, quality and appropriateness of the assaying and laboratory procedures used and whether the technique is considered partial or total.* • *For geophysical tools, spectrometers, handheld XRF instruments, etc., the parameters used in determining the analysis including instrument make and model, reading times, calibrations factors applied and their derivation, etc.* • *Nature of quality control procedures adopted (e.g. standards, blanks, duplicates, external laboratory checks) and whether acceptable levels of accuracy (i.e. lack of bias) and precision have been established.*	• Assaying and laboratory procedures are industry standard. • Analysis of assays was carried out at a certified laboratory, ALS Laboratory Group, Johannesburg, South Africa using a certified method (Au-AA26) with certified instruments. • ALS Laboratories Group internal checks as per their standard operating procedure were used for laboratory testwork. This results in the equivalent of 10 % of the total samples received being independently re-assayed as QAQC samples. • In 2012, 5 % of mineralised samples were re-assayed by SGS Perth and no material difference was found between the original ALS assays and the SGS umpire results. • Grind size testing was carried out and the results recorded in a laboratory log book. Digitisation of this data is in progress. • More recent exploration by KEFI has followed the same procedures using ALS Romania and Al Amri in Saudi Arabia.
Verification of sampling and assaying	• *The verification of significant intersections by either independent or alternative company personnel.* • *The use of twinned holes.* • *Documentation of primary data, data entry procedures, data verification, data storage (physical and electronic)*	• Significant intercepts were reviewed and verified visually by an independent consultancy, Wardell Armstrong, as part of preparing the resource statement for a definitive feasibility study carried out in November 2012. • KEFI Minerals Plc senior geological staff have also carried out in intensive six-month review of significant intersections and associated data.

Criteria	JORC Code Explanation	Commentary
	protocols. • *Discuss any adjustment to assay data.*	• Twinned holes have not been used on significant intercepts. • Up to 2012, primary data gathered in the field was recorded on paper logging sheets which were then transferred to an electronic database via a trained database manager. Following 2012, electronic logging was carried out for geological and geotechnical logging. • Assay results returned to the project from ALS were received in Excel format and copied in an in-house designed Access database. • The database is constructed so that automatic checks on the input data are carried out with both crushed and pulp duplicates plotted against the primary sample value. • No adjustment to assay data has been carried out.
Location of data points	• *Accuracy and quality of surveys used to locate drill holes (collar and downhole surveys), trenches, mine workings and other locations used in Mineral Resource estimation.* • *Specification of the grid system used.* • *Quality and adequacy of topographic control.*	• Drill hole and trench collar coordinates are initially located using GPS. When drilling has been completed, the collar location is re-surveyed using a Total Station by a geological survey team from Addis Ababa. • WGS84–Zone 36N grid was used. • In 2012, a LiDAR survey of the Tulu Kapi area was commissioned and new colour orthographic photos, covering some 52 km² (5 200 ha), as this provides complete coverage of the project, given the remote and rugged terrain in the area. This survey was completed by Fugro MAPS of United Arab Emirates. • From observations, it is apparent that that the drill hole collars do not match the LiDAR-generated digital terrain model. The average difference between the LiDAR survey and the collars is 2.7 m. For this resource estimate the digital terrain model that was generated by the LiDAR survey has subsequently been lowered by 2.7 m to better fit the drill hole collars. There are still small discrepancies between the LIDAR generated digital terrain model and the drill hole collars and it is recommended that a topographic survey be completed before the next resource estimate.
Data spacing and distribution	• *Data spacing for reporting of Exploration Results.* • *Whether the data spacing and distribution is sufficient to establish the degree of geological and grade continuity appropriate for the Mineral Resource and Ore Reserve estimation procedure(s) and classifications*	• 40 m × 40 m to 20 m × 20 m through the central part of the deposit to 40 m × 80 m at the peripheries. • From surface mapping, on strike continuity is on the 100 m scale. • Snowden and KEFI consider the drill spacing appropriate for the current classification of the Mineral Resource.

Criteria	JORC Code Explanation	Commentary
	applied. • *Whether sample compositing has been applied.*	• A 1 m sample composite length downhole has been applied after histogram analysis of sample length indicates the predominant sample length to be 1 m.
Orientation of data in relation to geological structure	• *Whether the orientation of sampling achieves unbiased sampling of possible structures and the extent to which this is known, considering the deposit type.* • *If the relationship between the drilling orientation and the orientation of key mineralised structures is considered to have introduced a sampling bias, this should be assessed and reported if material.*	• Drilling has generally been carried out on a 40 m grid orientated at an azimuth of 050° or vertically. The mineralisation is interpreted to strike north-northeast to south-southwest and dip 30° to the northwest, the drilling orientation is not ideal for sampling the principal mineralisation orientation, however, sufficient data density exists and sufficient work has been carried out via drill hole logging, detailed mapping and statistical analysis that the sampling is considered to be unbiased. • Sampling is not considered to be biased.
Sample security	• *The measures taken to ensure sample security.*	• Previous quality assurance protocol documentation and independent QA/QC audits undertaken by Venmyn Consultants (2009/2010) indicate that all chain of custody procedures have been in place and followed from early on in the exploration process. Custody procedures included and cover the signing-off of sheets for the transfer of core from rig to core shed, core sampling to sample preparation, and prepared samples from sample preparation facilities to Addis Abba and then by air freight to ALS in Johannesburg and receipt of samples at the analytical laboratory. • More recent exploration by KEFI has followed the same procedures with ALS Romania and Al Amri in Saudi Arabia.
Audits or reviews	• *The results of any audits or reviews of sampling techniques and data.*	• A significant amount of independent auditing and review of sampling techniques and data have been carried out by a variety of consultants since 2009, including Wardell Armstrong for the 2012 definitive feasibility study who considered no significant issues regarding the integrity of the database and that it was fit for purpose. • As part of the August 2014 Mineral Resource, Snowden has independently validated the database and found no material issues. Snowden considers the database appropriate for use in resource estimation.

Table 4-18: Section 2 Reporting of Exploration Results

(Criteria listed in the preceding Section also apply to this Section.)

Criteria	JORC Code Explanation	Commentary
Mineral tenement and land tenure status	• *Type, reference name/number, location and ownership including agreements or material issues with third parties such as joint ventures, partnerships, overriding royalties, native title interests, historical sites, wilderness or national park and environmental settings.* • *The security of the tenure held at the time of reporting along with any known impediments to obtaining a licence to operate in the area.*	• The Tulu Kapi licence was originally granted to Golden Prospect Mining Company Limited (GPMC) in May 2005 as the Tulu Kapi and Ankore Exploration Licence, number 127-128/97, covering an area of 20.32 km^2. GPMC was acquired by Nyota and became a wholly owned subsidiary in October 2009 and subsequently changed its name to Nyota Minerals (Ethiopia) Limited (NME). Since its grant in 2005 portions of the licence area have been progressively relinquished as required under Ethiopian mining law, such that it now consists of an irregular polygonal shape having a total area of 8.44 km^2. • In addition to the Tulu Kapi licence, the Tulu Kapi project and the conversion application include the adjacent Ankore licence areas, for a total area covered of 11.33 km^2. • The Tulu Kapi licence is currently an exploration licence (EL). An application to convert it to a Large Scale Mining Licence (MLA) was made on 11 May 2011. Under Ethiopian law an exploration licence gives the holder the exclusive right to explore for minerals within the area specified in the licence for an initial period of three years. The licence may be renewed twice for additional terms of one year each. The licensing authority may further allow extension or renewal to be made on each anniversary where the licensee proves the necessity to undertake exploration activity beyond the initial work programme, provided such period does not exceed a further five years in total. The Tulu Kapi licence was in its third renewal period (issued 25 May 2010 for a period of one year) when Nyota applied for a mining licence on 11 May 2011. Nyota received assurances from the Ministry of Mines that title to the Tulu Kapi licence endures while the mining licence application is processed. • Nyota withdrew the MLA in 2013 and in 2013; the Tulu Kapi EL was renewed to May 2015. • KEFI Minerals Plc (KEFI) acquired 75 % of the share capital of NME, the owner of the Tulu Kapi Project and surrounding Exploration Licences, in December 2013. • NME underwent a name change in 2014 to KEFI Minerals (Ethiopia) Ltd (KME). • KEFI announced the acquisition of the remaining 25 % of KME in June 2014. The sale was approved by Nyota Minerals Ltd shareholders in September 2014; this gives KEFI 100 % ownership of the Tulu Kapi project.

Criteria	JORC Code Explanation	Commentary
Exploration done by other parties	• *Acknowledgment and appraisal of exploration by other parties.*	• An Italian company, SAPIE, discovered the Tulu Kapi project in the 1930s and mined 947 000 m^3 at 1.22 g/m^3 for 1 154 kg of gold. • The earliest formal exploration of the Tulu Kapi area took place in the 1970s under the guidance of the UNDP, which undertook reconnaissance exploration over a wide area of western Ethiopia between 1969 and 1972. The work was largely reconnaissance level and regionally biased and included stream sediment and geochemical soil sampling programmes, geophysical surveys, detailed geological mapping, and diamond drilling. • Tan Range Exploration Company (TREC), a Canadian registered company, acquired an exploration licence over an area that incorporated the current Tulu Kapi licence and undertook further exploration between 1996 and 1998, including detailed geochemical soil sampling, mobile metal ion soil geochemistry, and an IP survey. Five diamond drill holes totalling 366 m were drilled in a 200 m × 200 m area immediately north of the old SAPIE mining area which targeted coincident geochemical soil and IP anomalies. • The Tulu Kapi - Ankore Exploration Licence (Tulu Kapi or Tulu Kapi Licence) was granted to Minerva Resources through its wholly owned subsidiary Golden Prospect Mining Company (GPMC) on 27 May 2005. GPMC undertook further detailed geological mapping, trenching, geophysics and diamond drilling within the licence area and the data generated by TREC was adopted subsequently by GPMC who geo-referenced it to UTM coordinates from local grids. In 2006, GPMC excavated two new trenches and undertook geological mapping and sampling. It subsequently conducted IP-resistivity surveys (two profiles aligned along a northeast-southwest direction) covering an area of 400 m × 400 m in May 2009 and additional gradient resistivity work covering an area of 800 m × 400 m and a ground magnetic survey covering 2.5 km × 1.2 km. Diamond drilling was carried out on an 80 m × 80 m grid and included 34 inclined holes, centred on gold soil anomalies, to a maximum depth of 200 m. • Minerva Resources (GPMC's parent company) was acquired by Dwyka Resources Limited (now Nyota Minerals Limited) in July 2009, making GPMC a wholly owned subsidiary. Following this acquisition an aggressive exploration programme commenced, comprising some early trenches (14), exploration/resource definition drilling and infill resource drilling using both diamond drilling and RC drilling.

Criteria	JORC Code Explanation	Commentary
		• Up to December 2012, 296 diamond drill holes for a total of 72 000 m, including the 34 diamond drill holes completed by GPMC and 38 diamond tails for 10 541 m; and 332 RC drill holes for a total of 45 000 m, have been completed at Tulu Kapi. • Since acquisition of the Project by Nyota, Mineral Resource estimates reported in compliance with the JORC Code and a NI 43-101 PEA have been completed by independent geological and mining consultants, Hellman and Schofield of Australia, Venmyn Rand (Pty) Ltd of South Africa, SRK Consulting of the UK and Wardell Armstrong of the UK.
Geology	• *Deposit type, geological setting and style of mineralisation.*	• The Tulu Kapi gold deposit is an orogenic gold deposit located in an area consisting of rocks ranging from Pre-Cambrian to Tertiary in age. The gold mineralisation at Tulu Kapi is hosted by an Upper Proterozoic age intrusive, which comprises a coarse grained syentite pluton. These rocks have been intruded into a volcano-sedimentary sequence that was subsequently transformed to mafic and sericitic schists. • The Tulu Kapi primary mineralisation is hosted in mafic syenite. The unaltered syenite is predominantly a medium to coarse-grained rock composed of 60 % to 70 % pink to white alkali feldspar, 20 % to 25 % plagioclase, and 10 % to 15 % ferromagnesian minerals and minor interstitial quartz. The ferromagnesian minerals appear to consist mainly of biotite with minor amphibole and magnetite. The mineralisation is associated with shallow (approximately 30°) southwest dipping zones of dense quartz-veining, enveloped by an auriferous, highly albitised, metasomatic alteration centred on the Bedele shear zone. • The albitised zones are of a lensoid nature comprising discrete stacked bodies that pinch and swell both along strike and down dip. A gradational contact of only a few centimetres with the unaltered mafic syenite is exhibited and the thickness of the individual albitised zones is highly variable. Mafic rocks (dolerite) representing dykes and/or sills are present within the syenite and are up to 10 m in thickness.
Drill hole Information	• *A summary of all information material to the understanding of the exploration results including a tabulation of the following information for all Material drill holes:* - *easting and northing of the drill hole collar*	• No exploration conducted during the period covered by the Resource statement.

Criteria	JORC Code Explanation	Commentary
	- *elevation or RL (Reduced Level – elevation above sea level in metres) of the drill hole collar* - *dip and azimuth of the hole* - *downhole length and interception depth* - *hole length.* • *If the exclusion of this information is justified on the basis that the information is not Material and this exclusion does not detract from the understanding of the report, the Competent Person should clearly explain why this is the case.*	
Data aggregation methods	• *In reporting Exploration Results, weighting averaging techniques, maximum and/or minimum grade truncations (e.g. cutting of high grades) and cut-off grades are usually Material and should be stated.* • *Where aggregate intercepts incorporate short lengths of high grade results and longer lengths of low grade results, the procedure used for such aggregation should be stated and some typical examples of such aggregations should be shown in detail.* • *The assumptions used for any reporting of metal equivalent values should be clearly stated.*	• No exploration conducted during the period covered by the Resource statement.
Relationship between mineralisation widths and intercept lengths	• *These relationships are particularly important in the reporting of Exploration Results.* • *If the geometry of the mineralisation with respect to the drill hole angle is known, its nature should be reported.* • *If it is not known and only the downhole lengths are reported, there should be a clear statement to this effect (e.g. 'downhole length, true width not known').*	• No exploration conducted during the period covered by the Resource statement.

Criteria	JORC Code Explanation	Commentary
Diagrams	• *Appropriate maps and sections (with scales) and tabulations of intercepts should be included for any significant discovery being reported These should include, but not be limited to a plan view of drill hole collar locations and appropriate sectional views.*	• No exploration conducted during the period covered by the Resource statement.
Balanced reporting	• *Where comprehensive reporting of all Exploration Results is not practicable, representative reporting of both low and high grades and/or widths should be practiced to avoid misleading reporting of Exploration Results.*	• No exploration conducted during the period covered by the Resource statement.
Other substantive exploration data	• *Other exploration data, if meaningful and material, should be reported including (but not limited to) geological observations; geophysical survey results; geochemical survey results; bulk samples – size and method of treatment; metallurgical test results; bulk density, groundwater, geotechnical and rock characteristics; potential deleterious or contaminating substances.*	• No exploration conducted during the period covered by the Resource statement.
Further work	• *The nature and scale of planned further work (e.g. tests for lateral extensions or depth extensions or large-scale step-out drilling).* • *Diagrams clearly highlighting the areas of possible extensions, including the main geological interpretations and future drilling areas, provided this information is not commercially sensitive.*	• Currently 3 000 m of resource infill drilling is planned in 40 RC holes.

Table 4-19: Section 3 Estimation and Reporting of Mineral Resources

(Criteria listed in Section 1, and where relevant in Section 2, also apply to this Section.)

Criteria	JORC Code Explanation	Commentary
Database integrity	• *Measures taken to ensure that data has not been corrupted by, for example, transcription or keying errors, between its initial collection and its use for Mineral Resource estimation purposes.* • *Data validation procedures used.*	• Exploration work was conducted under a quality management system involving all stages of exploration, from the drilling and sample collection to resource estimation. All field data was either captured in hard copy and subsequently uploaded to a spreadsheet system, or captured electronically, checked for consistency and added to the database with all original entered spreadsheets stored. The database was checked for input errors at different stages, from the field office to the head office in Addis Ababa. The master database is managed by a Geological Database/GIS Manager based at Tulu Kapi, with a quality control and sampling protocol coordinated by a quality control manager. • Snowden carried out basic validation checks on the data supplied by the Company prior to resource estimation. No significant errors were identified by the validation.
Site visits	• *Comment on any site visits undertaken by the Competent Person and the outcome of those visits.* • *If no site visits have been undertaken indicate why this is the case.*	• Extensive site visits carried out by KEFI personnel over a period of six months for data verification and review including working with local staff on site who have a long history with the project and qualified expatriate staff also familiar with the project. All relevant data, physical and digital was reviewed as well as technical procedures for cataloguing, recording, storing and using the results of data. No significant issues or problems were observed. • A site visit was completed by Snowden between 17 July and 23 July 2014. The site visit included a review of general geology, drilling, sampling and assaying procedures, on-site laboratory, bulk density measurement procedure, logging procedures and QA/QC. No material issues or problems were observed.
Geological interpretation	• *Confidence in (or conversely, the uncertainty of) the geological interpretation of the mineral deposit.* • *Nature of the data used and of any assumptions made.* • *The effect, if any, of alternative interpretations on Mineral Resource estimation.* • *The use of geology in guiding and controlling Mineral Resource estimation.*	• Geological and structural interpretation of the Tulu Kapi area has been based on surface mapping and drill hole interpretation and logging by a variety of consultants and qualified national staff working for the project since 2009. All data available has been used and is also available for review in digital or analogue format • An alternative interpretation is only likely to be regarding subtle controls on mineralisation, particularly local variations in strike, dip and thickness of mineralised zones and is unlikely to materially affect the estimate.

Criteria	JORC Code Explanation	Commentary
	• *The factors affecting continuity both of grade and geology.*	• Mineralisation domains were interpreted using a 0.3 g/t Au cut-off as a guide. The 0.3 g/t Au cut-off was determined from a log-probability plot that showed a change in distribution at this grade. The wireframes were produced using 10 m cross sections and orientated based on the structural interpretation which dips around 30° to the west-northwest. • Mineralised domains are defined within the Central and UNDP (northern) areas of the deposit which are separated by faulting. • A complex structural environment and genesis exists with narrow shallowly dipping stacked veins which pinch and swell along strike and down dip. • The relationship with grade, alteration, quartz veining and structure are not yet fully understood however structural geology interpretation and investigation is beginning to improve the understanding of the factors controlling grade continuity.
Dimensions	• *The extent and variability of the Mineral Resource expressed as length (along strike or otherwise), plan width, and depth below surface to the upper and lower limits of the Mineral Resource.*	• Mineralisation as modelled extends for some 980 m along strike, 520 m in width near surface and extending to a depth of some 560 m. Mineralisation narrows to the south and narrows to the north at depth within the currently interpreted mineralisation boundaries.
Estimation and modelling techniques	• *The nature and appropriateness of the estimation technique(s) applied and key assumptions, including treatment of extreme grade values, domaining, interpolation parameters and maximum distance of extrapolation from data points. If a computer-assisted estimation method was chosen include a description of computer software and parameters used.* • *The availability of check estimates, previous estimates and/or mine production records and whether the Mineral Resource estimate takes appropriate account of such data.* • *The assumptions made regarding recovery of by-products.* • *Estimation of deleterious elements or other non-grade variables of economic significance (e.g. sulphur for acid mine drainage characterisation).* • *In the case of block model interpolation, the block size in*	• The 1 m composites were coded within the mineralised domain and by major fault block (Central and UNDP). Given the shallow oxidation profile, no separation was carried out by oxidation domain. • The data distributions are highly skewed and typically have a high (> 1.5) coefficient of variation (CV – ratio of standard deviation to the mean). As a result, top cuts were applied to prevent overestimation and smearing of the comparatively high values into surrounding blocks. A top cut of 70 g/t Au was used for the Central domain and impacted approximately 0.1 % of the grade population. No top cut was applied to the UNDP domain as no outliers occur in this area. • Grade estimation was carried out in CAE Studio 3 (Datamine) using ordinary kriging with dynamic anisotropy to align the estimation with the local dip and strike of the mineralisation trends, into 10 mE × 10 mN × 1 mRL parent cells. Block discretisation was set to 4 × 4 × 2. • A kriging neighbourhood analysis was carried out to determine optimal block size and

Criteria	JORC Code Explanation	Commentary
	relation to the average sample spacing and the search employed. • *Any assumptions behind modelling of selective mining units.* • *Any assumptions about correlation between variables.* • *Description of how the geological interpretation was used to control the resource estimates.* • *Discussion of basis for using or not using grade cutting or capping.* • *The process of validation, the checking process used, the comparison of model data to drill hole data, and use of reconciliation data if available.*	estimation parameters. The estimation was performed on the mineralised and non-mineralised material defined within each domain (Central and North). • Estimation was run in a three-pass kriging plan, the second and third passes using progressively larger search radii to enable the estimation of blocks not estimated on the previous pass. The search parameters were derived from the variogram analysis, with the first search distances corresponding to the distance at approximately half of the variogram sill value and the second search distance approximating up to the variogram range. • Blocks were estimated using a minimum of 8 with a maximum of 24 samples (6 minimum and 24 maximum for pass 2) and a maximum of 4 composites allowed per drill hole. • The maximum distance of extrapolation points within the method was 80 m. • The previous resource estimate was carried out by Snowden in August 2014. Comparison between the January 2015 and August 2014 estimates for Indicated material shows the most recent estimate has reported 2 % more tonnes, 4 % more grade and 6 % more ounces than the August 2014 estimate. This is based on the potential for both open-pit and underground mining using cut-offs of 0.45 g/t Au and 2.5 g/t Au, respectively. • Tulu Kapi is essentially a gold deposit and due to the low unit value of silver, all exploration work and resource estimates have focused on gold and no emphasis has been placed on the presence of, and estimate of a silver Mineral Resource. KEFI did not carry out an estimate of silver resources in this resource update. • Following grade estimation, a statistical and visual assessment of the block model was undertaken for validation purposes. Visual comparison of composite sample grade and block grade was conducted in cross section and in plan. Visually the model was considered to spatially reflect the composite grades. Statistical analysis of the block model was carried out for comparison against the composited drill hole data. The mean block model grade for each domain and its corresponding mean composite grade compared well as did global averages. Sectional trend plots were generated which indicate that there is a good local reproduction of the input grades in both the horizontal and vertical directions. No obvious interpolation issues were identified and there is no evidence of significant over or under-estimation apparent in the model.

Criteria	JORC Code Explanation	Commentary
Moisture	• *Whether the tonnages are estimated on a dry basis or with natural moisture, and the method of determination of the moisture content.*	• Tonnages were estimated on a dry basis.
Cut-off parameters	• *The basis of the adopted cut-off grade(s) or quality parameters applied.*	• Previous mineralised zone interpretations from the November 2012 resource estimate by Wardell Armstrong were based on contiguous length analyses to define the mineralisation and identify a suitable grade boundary to separate mineralised from non-mineralised syenite. A cut-off grade of 0.3 g/t Au was used in the 2012 resource estimate to define the mineralisation for both the saprolite and fresh material. KEFI and Snowden have kept the same cut-off grade after reviewing the grade distributions and agreeing that there is a change in population at around 0.3 g/t Au. • The reporting cut-off for the Mineral Resource is 0.45 g/t Au for open-pit material (above 1 400 mRL) and 2.5 g/t Au for underground potential (below 1 400 mRL) which is based on open-pit optimisation studies carried out as part of the previous definitive feasibility study.
Mining factors or assumptions	• *Assumptions made regarding possible mining methods, minimum mining dimensions and internal (or, if applicable, external) mining dilution. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential mining methods, but the assumptions made regarding mining methods and parameters when estimating Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the mining assumptions made.*	• The Mineral Resource has been reported as mineable by open-pit methods above 1 400 mRL which is the bottom out elevation for the pit optimisation shells generated as part of the definitive feasibility study. • Below 1 400 mRL ,the Mineral Resource is reported as potentially mineable by underground methods.
Metallurgical factors or assumptions	• *The basis for assumptions or predictions regarding metallurgical amenability. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider potential metallurgical methods, but the assumptions regarding metallurgical treatment processes and parameters made when reporting*	• Metallurgical testwork was carried out to definitive feasibility study level during the November 2012 resource period and demonstrated feasible metallurgical recovery for the Tulu Kapi project. This information was reviewed by KEFI technical staff and confirmed to be technically and economically sound.

Criteria	JORC Code Explanation	Commentary
	Mineral Resources may not always be rigorous. Where this is the case, this should be reported with an explanation of the basis of the metallurgical assumptions made.	
Environmental factors or assumptions	• *Assumptions made regarding possible waste and process residue disposal options. It is always necessary as part of the process of determining reasonable prospects for eventual economic extraction to consider the potential environmental impacts of the mining and processing operation. While at this stage the determination of potential environmental impacts, particularly for a greenfields project, may not always be well advanced, the status of early consideration of these potential environmental impacts should be reported. Where these aspects have not been considered this should be reported with an explanation of the environmental assumptions made.*	• A detailed Environment Impact Statement and plant and infrastructure design was carried out to definitive feasibility study level during the November 2012 resource period and demonstrated the project to be environmentally sound and sustainable. This information was reviewed by KEFI technical staff and confirmed to be technically in compliance with relevant environmental laws and legislation.
Bulk density	• *Whether assumed or determined. If assumed, the basis for the assumptions. If determined, the method used, whether wet or dry, the frequency of the measurements, the nature, size and representativeness of the samples.* • *The bulk density for bulk material must have been measured by methods that adequately account for void spaces (vugs, porosity, etc.), moisture and differences between rock and alteration zones within the deposit.* • *Discuss assumptions for bulk density estimates used in the evaluation process of the different materials.*	• A global (dry) density value of 1.50 t/m^3 was used for all saprolite material. A global (dry) density value of 2.74 t/m^3 was used for all fresh material. From field measurements (approximately 14 000 samples), the average density of the mafic syenite (mineralisation) is 2.741 t/m^3. • Density values for the fresh material have been derived from density measurements carried out by ROCKLAB supplemented by additional density testing on site by Nyota and KEFI. The measurements represent a dry density. • In 2012, Nyota submitted 56 samples of saprolite material for analysis at Water Works and Supervision Enterprise Laboratory Service Sub Process, Addis Ababa, Ethiopia. The results of this testwork recorded an average bulk density of 1.86 gm/cc and dry density of 1.47 gm/cc. In 2014, KEFI submitted 27 saprolite samples to ALS laboratory in Romania for analysis; these had an average dry density of 1.57 gm/cc. This gives an overall average for the 83 samples of 1.50 gm/cc. • KEFI has planned to implement an ongoing assessment of saprolite density checks.

Criteria	JORC Code Explanation	Commentary
Classification	• *The basis for the classification of the Mineral Resources into varying confidence categories.* • *Whether appropriate account has been taken of all relevant factors (i.e. relative confidence in tonnage/grade estimations, reliability of input data, confidence in continuity of geology and metal values, quality, quantity and distribution of the data).* • *Whether the result appropriately reflects the Competent Person's view of the deposit.*	• Criteria for defining resource categories were derived from a combination of the geostatistical studies (grade continuity), interpreted structural continuity and drill hole spacing. • The main central area of the deposit coincides with the greatest orebody thicknesses and also the greatest continuity of mineralisation. The drill hole spacing in this area is generally on a 40 m × 40 m grid, down to 20 m × 20 m in some areas and is therefore relatively well drilled for the mineralisation style. The nature of the geological and grade continuity encountered within the deposit means this area is considered to be suitable for reporting of Indicated Mineral Resources. • In areas outside the central zone the orebody thickness and continuity of mineralisation appear to decrease and drill hole spacing in these areas ranges from 40 m × 80 m up to 80 m × 80 m. The drill hole spacing and nature of mineralisation in these areas are suitable for reporting of Inferred Mineral Resources. • For the central zone, search radii used during grade estimation were also used to define classification. Consistent areas of blocks estimated in the first and second searches (within the variogram range) and/or where mineralised structures were clearly defined by consistent drill intersections were classified as Indicated Resources. Blocks consistently estimated in the third search pass were classified as Inferred Resources. • The majority of Mineral Resources contained within the north fault block (UNDP) are classified as Inferred Resources. A portion representing more closely spaced drilling (approximately 40 m × 40 m), which was estimated in first and second search passes and/or where mineralised structures were clearly defined by consistent drill intersections was classified as Indicated.
Audits or reviews	• *The results of any audits or reviews of Mineral Resource estimates.*	• Snowden has internally peer-reviewed the estimate. Snowden considers that there are no material issues with the estimate.
Discussion of relative accuracy/ confidence	• *Where appropriate a statement of the relative accuracy and confidence level in the Mineral Resource estimate using an approach or procedure deemed appropriate by the Competent Person. For example, the application of statistical or*	• Statistical and visual validation and checking of the block model confirm it performs as expected globally and locally in plan and section within the 2014 drill database and structural comparison with surface and trench mapping confirm mineralised zones to outcrop where expected and be the approximate thickness as indicated by the block

Criteria	JORC Code Explanation	Commentary
	geostatistical procedures to quantify the relative accuracy of the resource within stated confidence limits, or, if such an approach is not deemed appropriate, a qualitative discussion of the factors that could affect the relative accuracy and confidence of the estimate. • *The statement should specify whether it relates to global or local estimates, and, if local, state the relevant tonnages, which should be relevant to technical and economic evaluation. Documentation should include assumptions made and the procedures used.* • *These statements of relative accuracy and confidence of the estimate should be compared with production data, where available.*	model. • Model validation, the drilling grid and observation of the grade and mineralisation continuity lead KEFI to consider the central part of the deposit suitable for an Indicated Resource category and peripheral areas suitable for an Inferred Resource category. • The nature of the mineralisation and the relatively high nugget content may result in local grade estimates being of a relatively low confidence. It is likely that closely spaced channel sampling/bulk sampling or grade control drilling will be required for the classification of Measured Resources.

4.13.2 Tulu Kapi Resource Classification Scheme

The Tulu Kapi Mineral Resource estimate was classified and reported in accordance with the JORC Code (2012). Model blocks were flagged as Indicated, Inferred or Unclassified using wireframes which were developed based on a combination of geostatistical studies (grade continuity), interpreted structural continuity and drill hole spacing as described below.

The main central area of the deposit coincides with the greatest orebody thicknesses and also the greatest continuity of mineralisation. The drill hole spacing in this area is generally on a 40 m × 40 m grid, down to 20 m × 20 m in some areas and is therefore relatively well drilled for the mineralisation style. The nature of the geological and grade continuity encountered within the deposit means this area is considered to be suitable for reporting of Indicated Mineral Resources.

In areas outside the central zone the orebody thickness and continuity of mineralisation appear to reduce and drill hole spacing in these areas ranges from 40 m × 80 m up to 80 m × 80 m. The drill hole spacing and nature of mineralisation in these areas are suitable for reporting of Inferred Mineral Resources.

For the central zone, search radii used during grade estimation were also used to define classification. Consistent areas of blocks estimated in the first and second searches (within the variogram range) and/or where mineralised structures were clearly defined by consistent drill intersections were classified as Indicated Resources. Blocks consistently estimated in the third search pass were classified as Inferred Resources.

The majority of Mineral Resources contained within the north fault block (UNDP) are classified as Inferred Resources. A portion representing more closely spaced drilling (approximately 40 m × 40 m), which was estimated in first and second search passes and/or where mineralised structures were clearly defined by consistent drill intersections was classified as Indicated.

The classification was recorded in the model using a field called RESCAT, which is described in Table 4-20.

Table 4-20: Resource Classification Model Field Values

RESCAT Field Value	Description
0	Not classified
2	Indicated
3	Inferred

While exercising all reasonable due diligence in checking and confirming the data validity, Snowden has relied largely on the data as supplied by KEFI to estimate and classify the Mineral Resource. As such, Snowden accepts responsibility for the geological interpretation, resource modelling and classification, while KEFI has assumed responsibility for the accuracy and quality of the underlying drilling data.

In the 1930s, some hydraulic mining of the Tulu Kapi hill adjacent to the Bedele shear zone was undertaken by an Italian outfit. Mining concentrated on the weathered material and it is believed that less than 40 000 oz was recovered. There is no survey of the area mined with the workings now filled in and covered with vegetation. The previous mining is immaterial to the current resource estimate as it is predominantly in fresh rock and depletion has not been allowed for.

4.14 MINERAL RESOURCE REPORTING

The classified Mineral Resources for the Tulu Kapi deposit have been reported using a 0.45 g/t Au cut-off grade for a potential open-pit resource above the 1 400 mRL and a 2.5 g/t Au cut-off grade for a potential underground resource below the 1 400 mRL. The elevation limit and cut-off grades are based on open-pit optimisation studies carried out as part of reviews of the previous definitive feasibility study works.

The total Mineral Resource for the Tulu Kapi deposit, as at January 2015, is reported in Table 4-21.

Table 4-21: January 2015 Tulu Kapi Mineral Resource Estimate Reported above a 0.45 g/t Au cut-off and 2.5 g/t Au cut-off

JORC (2012) Resource Category	Reporting Elevation	Cut-off (g/t Au)	Tonnes (Mt)	Au (g/t)	Ounces (million)
Indicated	Above 1 400 RL	0.45	17.7	2.49	1.42
Inferred	Above 1 400 RL	0.45	1.28	2.05	0.08
Indicated and Inferred	**Above 1 400 RL**	**0.45**	**19.0**	**2.46**	**1.50**
Indicated	Below 1 400 RL	2.50	1.08	5.63	0.20
Inferred	Below 1 400 RL	2.50	0.12	6.25	0.02
Indicated and Inferred	**Below 1 400 RL**	**2.50**	**1.20**	**5.69**	**0.22**
Total Indicated	All		18.8	2.67	1.62
Total Inferred	All		1.40	2.40	0.10
Total Indicated and Inferred	**All**		**20.2**	**2.65**	**1.72**
All numbers are reported to three significant figures. Small discrepancies may occur due to the effects of rounding.					

Additionally, the Total Mineral Resource for Tulu Kapi, as at January 2015, is reported at various cut-offs with no consideration of mining method as outlined in Table 4-22.

Table 4-22: January 2015 Tulu Kapi Mineral Resource Estimate Reported at various cut-off grades

JORC (2012) Resource Category	Cut-off (g/t Au)	Tonnes (Mt)	Au (g/t)	Ounces (million)
Indicated	0.00	19.6	2.63	1.65
Inferred	0.00	1.60	2.21	0.11
Indicated and Inferred	**0.00**	**21.2**	**2.60**	**1.77**
Indicated	0.20	19.6	2.63	1.65
Inferred	0.20	1.59	2.23	0.11
Indicated and Inferred	**0.20**	**21.2**	**2.60**	**1.77**
Indicated	0.30	19.6	2.63	1.65
Inferred	0.30	1.56	2.26	0.11
Indicated and Inferred	**0.30**	**21.1**	**2.60**	**1.77**
Indicated	0.45	19.5	2.64	1.65
Inferred	0.45	1.52	2.31	0.11
Indicated and Inferred	**0.45**	**21.0**	**2.61**	**1.76**
Indicated	0.50	19.4	2.65	1.65
Inferred	0.50	1.51	2.32	0.11
Indicated and Inferred	**0.50**	**20.9**	**2.62**	**1.76**
Indicated	1.00	16.5	2.97	1.58
Inferred	1.00	1.02	3.05	0.10
Indicated and Inferred	**1.00**	**17.5**	**2.98**	**1.68**
Indicated	2.50	7.10	4.72	1.08
Inferred	2.50	0.47	4.80	0.07
Indicated and Inferred	**2.50**	**7.57**	**4.73**	**1.15**
Indicated	5.00	2.12	7.79	0.53
Inferred	5.00	0.18	6.94	0.04
Indicated and Inferred	**5.00**	**2.30**	**7.72**	**0.57**
All numbers are reported to three significant figures. Small discrepancies may occur due to the effects of rounding.				

4.15 COMPARISON WITH PREVIOUS ESTIMATES

The most recent estimate was compiled in August 2014 by Snowden. Snowden reported the model using a 0.45 g/t Au cut-off above the 1 400 mRL and 2.5 g/t Au below the 1 400 mRL for comparison purposes. The resource reporting is listed in Table 4-23.

Table 4-23: Tulu Kapi Resource Estimate as at August 2014 reported above a 0.45 g/t Au cut-off and 2.5 g/t Au cut-off

JORC (2012) Resource Category	Reporting Elevation	Cut-off (g/t Au)	Tonnes (Mt)	Au (g/t)	Ounces (million)
Indicated	Above 1 400 RL	0.45	17.3	2.37	1.32
Inferred	Above 1 400 RL	0.45	4.77	1.91	0.29
Indicated and Inferred	**Above 1 400 RL**	**0.45**	**22.1**	**2.27**	**1.61**
Indicated	Below 1 400 RL	2.50	1.07	5.88	0.20
Inferred	Below 1 400 RL	2.50	0.56	5.67	0.10
Indicated and Inferred	**Below 1 400 RL**	**2.50**	**1.63**	**5.81**	**0.30**
Total Indicated	All		18.4	2.57	1.52
Total Inferred	All		5.33	2.30	0.39
Total Indicated and Inferred	**All**		**23.7**	**2.51**	**1.91**

A global comparison between the Snowden January 2015 estimate and the Snowden August 2014 estimate shows that the January 2015 estimate reported 15 % less tonnes, 6 % more grade and 10 % less ounces than the August 2014 estimate. This is based on the potential for both open-pit and underground mining using cut-offs of 0.45 g/t Au and 2.5 g/t Au, respectively.

The differences between the models can be attributed to the creation of wireframes to better define mineralised domains for the January 2015 estimate as compared to the indicator approach used for the August 2014 estimate. The wireframes have refined and tightened the mineralised domains, which have resulted in less tonnes at a higher grade for overall less ounces.

Within the Indicated Resources, the tonnes have increased by 2 % and the grade by 4 % for a 6 % increase in ounces. This is a result of the new interpretation together with a slight expansion of the area classified as Indicated, resulting from the increased confidence in the geological model.

4.16 RECOMMENDATIONS

Snowden has the following recommendations:

- There are discrepancies between the LiDAR generated digital terrain model and the drill hole collars and it is recommended that a more accurate topographic survey be completed before the next resource estimate.
- Snowden notes that the downhole surveying method employed can be impacted by magnetic interference from the rocks and potentially the drill string. It is recommended that KEFI survey some holes, especially deeper holes, using a non-magnetic method (e.g. gyroscopic survey) to assess the impact of any magnetic interference on the azimuth measurements.
- For dry samples, the splitting approach adopted by Nyota and KEFI is reasonable and should produce reasonably representative samples, assuming the sample is introduced into the splitter properly. However, for wet samples, Snowden recommends that KEFI use a cone splitter in future drilling programmes as the current practice of spearing is incorrectly delimited and likely introducing a high sampling error.
- RC duplicate results show relatively poor precision and Snowden recommends that the RC splitting process be reviewed.
- Procedures are not well documented and it is recommended that KEFI develop official procedures associated with drilling, logging, sampling, sample preparation, assaying and QA/QC.
- Check assays should be sent to an umpire laboratory on a regular basis and that standards be included in the batches sent.

4.17 REFERENCES

JORC, 2012. *The Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves*, The JORC Code 2012 Edition, the Joint Ore Reserves Committee of the Australian Institute of Mining and Metallurgy, Australian Institute of Geoscientists and Mineral Council of Australia (JORC).

Snowden, 2014. *KEFI Minerals Ethiopia Tulu Kapi Resource Report August 2014*, August 2014, *unpublished report.*

Wardell Armstrong International, 2012. *Tulu Kapi Gold Project Definitive Feasibility Study*, November 2012, *unpublished report.*

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SECTION 5 -Ore Reserves and Mining

Tulu Kapi Gold Project
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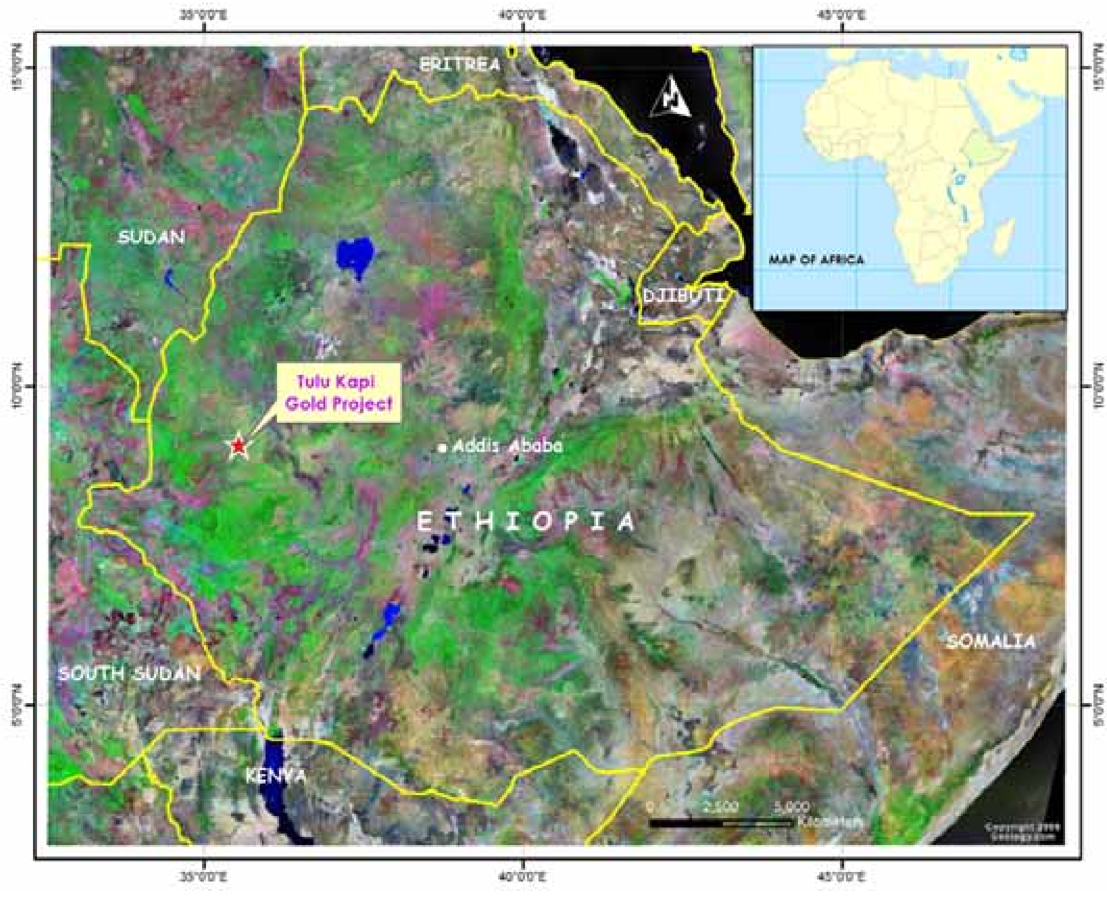
5.1 EXECUTIVE SUMMARY

In January 2015, Snowden Mining Industry Consultants ("Snowden") was retained by KEFI Minerals Ethiopia ("KEFI") to compile the mining study section for the Tulu Kapi ("Tulu") Gold Project Feasibility Study. The purpose of the work was to use the updated February 2015 Mineral Resource estimate and update the mine plans that were previously developed in October 2014 as part of the Tulu Kapi Ore reserve estimate.

The Tulu deposit is located in Western Ethiopia approximately 350 kilometres ("km") due west of the capital, Addis Ababa (Figure 5.1). Access to the project is by road and involves a 10-hour road trip on sealed and unsealed roads from Addis Ababa to the project site.

Figure 5.1 Location map of Tulu Kapi (KEFI)



5.1.1 Key strategic issues

The key mining related items facing the project are:

- The impact of dilution that will result from the mining process
- The effective implementation of a selective mining cycle that minimises dilution including:
  - Blasting products and methods that minimise movement and mixing that will cause dilution
  - Using reduced sized blasts and bench heights to assist in separating isolating the ore and waste

- o Using appropriate size machines with smaller buckets 6.7 m^3 to increase the digging selectivity of the ore whilst maintaining a reasonable production rate.

5.1.2 Reliance on external work

Snowden is reliant on work undertaken by other parties relating to non-mining issues including:

- Hydrology (surface and ground water)
- Metallurgy (process recovery)
- Blasting (KEFI supplied data that was modelled by blasting experts, Itasca)
- Processing infrastructure (operating and capital costs)
- Marketing (metal pricing)
- Lease, environmental and cultural restrictions.

Snowden also used the following studies that were completed by Snowden in early 2015 as a basis for its mine planning studies:

- Tulu Kapi Mineral Resource Report – internal report submitted to KEFI Minerals Ethiopia , February 2015
- Tulu Kapi Feasibility Study Geotechnical Assessment – internal report submitted to KEFI Minerals Ethiopia , May 2015.

Mobile plant pricing was predominantly provided by the local Ethiopian Komatsu distributor and modelled against productivity, resulting in comprehensive unit mining operating cost and capital cost estimation. Comprehensive mining costs were developed by Mine And Cost Engineering Pty Ltd. Other indirect mining costs including infrastructure were developed by KEFI and accepted by Snowden as part of the economic assessment.

Snowden also assessed the KEFI-developed financial model to understand the economic viability of the project. Snowden relied on a gold price of US$1,250 per ounce ("oz") as provided by KEFI. Snowden also relied on documents by KEFI and its consultants (provided by KEFI) which indicate that there are no environmental, approvals, licensing or permitting encumbrances hindering the estimation of Ore Reserves.

5.1.3 Mine planning

The mine planning work and Ore Reserve estimate was completed over a four-month period from February 2015 to May 2015. No site visit was undertaken by the Snowden Competent Person for Ore Reserves; instead, site visits were undertaken by a Snowden geologist for the Mineral Resource sign-off and the Tulu project metallurgist who was the Competent Person for the metallurgy and process sign-off. The Snowden Competent Person for Ore Reserves has relied on this site visit for confirmation of the existence of an Ore Reserve at Tulu.

Following a mine planning process, the following items were produced by Snowden:

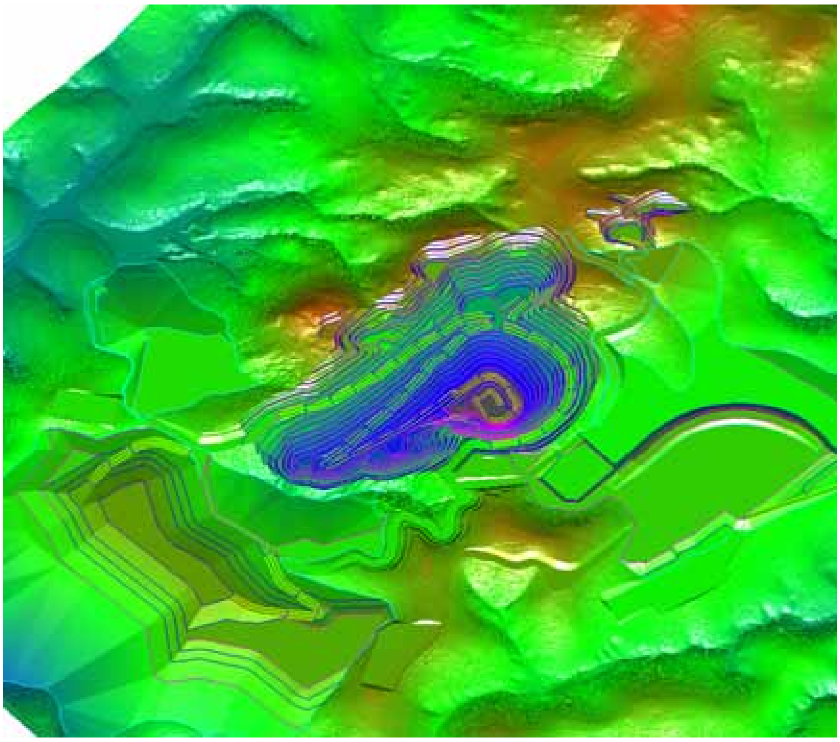
- A planned ore dilution assessment for the Tulu ore mineralisation that provided a diluted model with a 6% decrease in gold metal and a 6% increase in the ore tonnage at a cut-off of 0.9 grams per tonne gold ("g/t Au")
- Potential economic pit limits, identifying an ultimate surface for ore and waste extraction inclusive of 12.24 million tonnes ("Mt") of ore at a cut-off of 0.9 g/t, with a grade of 2.49 g/t for 0.98 million ounces ("Moz") in situ
- Pit designs using feasibility study geotechnical constraints that were developed by Snowden. The final pit contained (exclusive of ore losses):
- Ore 12.7 Mt

- Gold grade 2.52 g/t
- Gold metal (in situ) 1.03 Moz
- Waste 121.5 Mt
- Total tonnes 134.2 Mt
- Production scheduling that resulted in a viable supply of ore with a cut-off grade of 0.5 g/t at a rate of approximately 1.2 million tonnes per annum ("Mtpa") to the proposed Tulu plant for 12.2 years. The schedule physicals were reported exclusive of the quarry pit movements and inclusive of a 5% ore loss. The final mine production inventory provided:
- Processed ore 15.4 Mt
- Gold grade 2.12 g/t
- Gold metal recovered 960 Koz
- Waste mined 114.2 Mt
- Total tonnes 129.5 Mt
- Cost modelling to provide production scheduling with haulage paths and cycle times.

The final pit design and infrastructure layout is provided in Figure 5.2. A symmetric view of the pit in the final surface is provided in Figure 5.3.

Figure 5.2 Final pit design and infrastructure layout

Figure 5.3 Final surface northwest symmetric



5.1.4 Mining schedule

A mine production schedule was achieved with a three month pre-production period in year -1, and a process rate of 1.1 Mtpa in year 1 and a mill capacity of 1.2 Mtpa being reached in year 2 for the mill life of 13.3 years. The process schedule for the three different ore type is summarised annually in Table 5.1.

Table 5.1 Process and metal schedule

	Period	-1	1	2	3	4	5	6	7	8	9	10	11	12	13
Process															
Saprolite (kt)	937		362	59	29	24	0	23			16	158	3	0	261
- Grade – Au (g/t)	1.56		2.08	2.93	2.70	1.59	1.33	1.40			1.15	1.13	1.05	0.75	0.70
Fresh (kt)	10,091		738	1,141	1,171	1,057	1,200	781	244	176	587	691	1,034	1,200	71
- Grade – Au (g/t)	1.99		1.92	3.46	2.98	2.17	2.83	2.16	3.01	1.16	1.08	1.00	0.73	0.69	0.67
Hard (kt)	4,365					118		396	956	1,024	597	350	163		761
- Grade – Au (g/t)	2.54					3.82		3.09	2.80	2.95	3.54	2.60	0.95		0.70
Total (kt)	15,393		1,100	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,093
- Grade – Au (g/t)	2.12		1.97	3.44	2.97	2.32	2.83	2.45	2.84	2.68	2.30	1.48	0.76	0.69	0.70
Metal															
Mined - Au (koz)	1,047	4	83	191	136	76	129	95	129	104	68	29	1		
Feed - Au (koz)	1,050		70	133	115	90	109	95	110	104	89	57	29	27	25
Recovered - Au (koz)	960		65	123	106	82	101	86	99	93	80	52	26	24	22

Tonnage movements are provided graphically in Figure 5.4 to Figure 5.6. A stockpile of about 1.8 Mt is accumulated and processed by year 13.

Figure 5.4 Total tonnes mined (ore and waste)

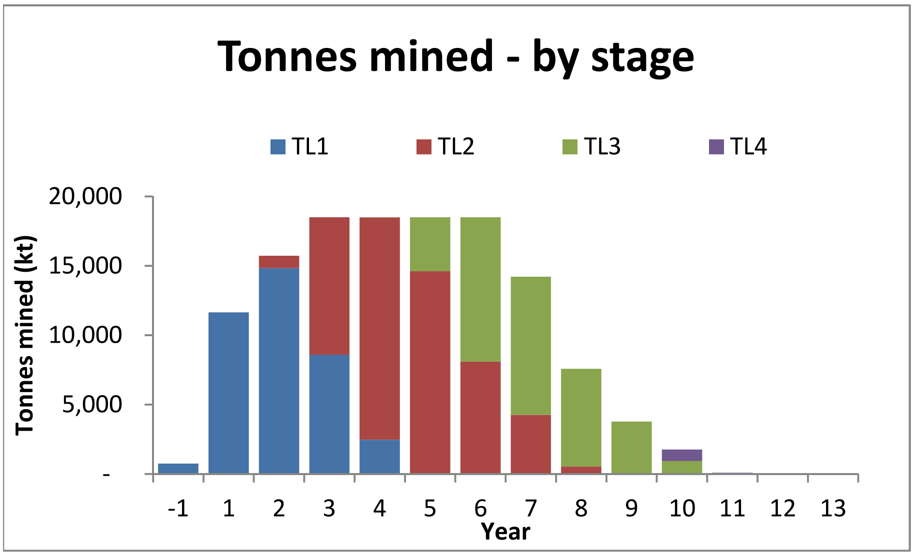


Figure 5.5 Ore tonnes mined

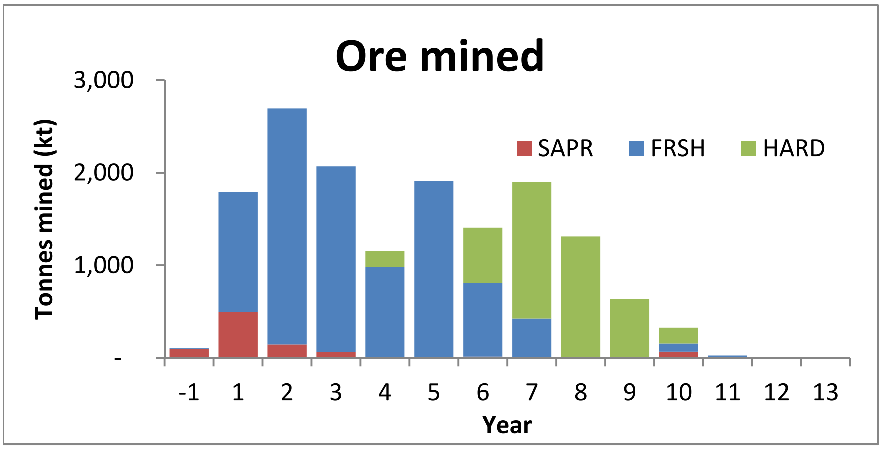
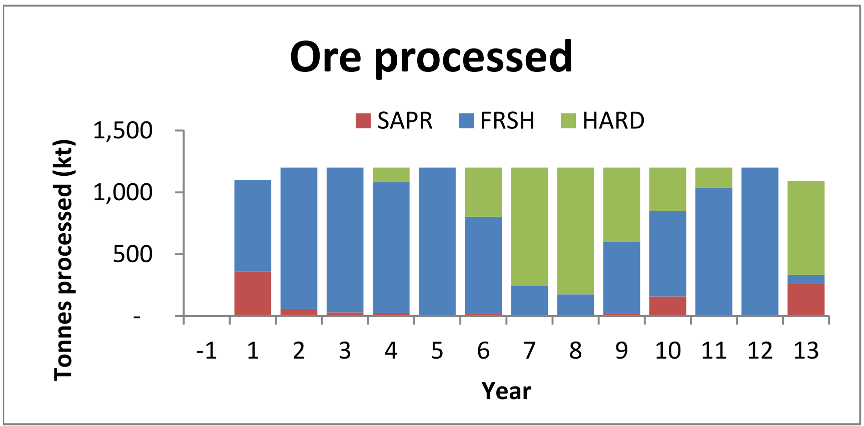


Figure 5.6 Ore tonnes processed by rock type



The process grade by rock type is provided Figure 5.7 and the mined, processed and recovered ounces are provided in Figure 5.8

Figure 5.7 Tulu Kapi processed grade by rock type

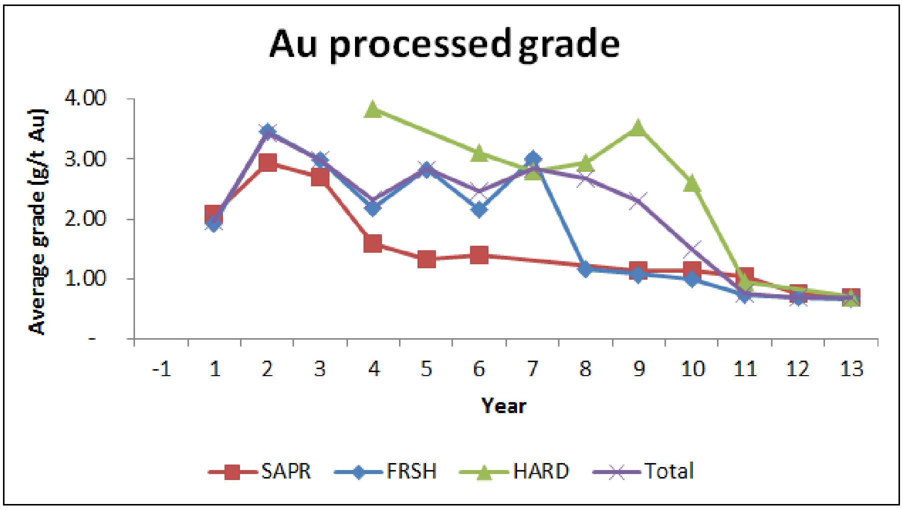
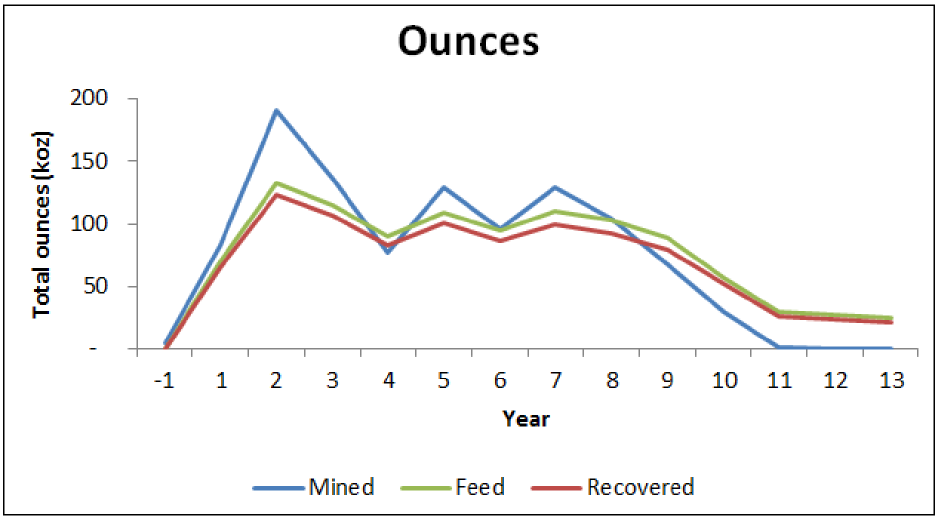


Figure 5.8 Tulu Kapi mined, processed and recovered ounces



5.1.5 Mining equipment

The mining equipment proposed for the Tulu Kapi project is given in Table 5.2.

Table 5.2 Mining fleet requirements

Description	Units	Maximum
Primary fleet		
Excavator 200 t	No.	3
Excavator 120 t	No.	1
Trucks 90 t	No.	13
Blasthole drills	No.	2
Reverse circulation drills	No.	4
Ancillary fleet		
Track dozer	No.	2
Wheel dozer	No.	1
Grader	No.	2
Water cart	No.	2
Batter digger	No.	1
Rock breaker	No.	1
Stemming truck	No.	1
Lighting tower provision	No.	6
Fuel and lube truck	No.	1
Other		

Minor equipment	No.	9
Light vehicles (including buses)	No.	21

5.1.6 Capital and operating costs

Capital and operating costs were estimated from vendor quotations sourced specifically for the project. Operating costs consider plant, labour, material and contractor costs and covered all activities associated with the pit operations including clearing the site, drill and blast, load and haul and rehabilitating the waste dumps. Capital costs included the scheduled procurement of the equipment described in Section 5.9 and where appropriate the replacement of that equipment to maintain reasonable average age of machines across the fleet. Costs were allocated to capital development where they were incurred during a pre-production. Year -2 is the construction period.

A summary of the Tulu Kapi mining operations is given in Table 5.3.

Table 5.3 Tulu Kapi mining operations summary

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Ore from Borrow + Mine																		
Oxide Ore	Mt	0.012	0.137	0.495	0.145	0.064	0.000	0.001	0.014	-	-	-	0.066	0.002	-	-	-	0.937
- Grade (Au)	g/t	1.69	1.41	1.53	1.85	1.72	3.58	0.72	1.24	-	-	-	1.29	1.09	-	-	-	1.56
Fresh Ore	Mt	0.002	0.016	1.298	2.550	2.005	0.980	1.909	0.793	0.425	-	-	0.089	0.024	-	-	-	10.091
- Grade (Au)	g/t	2.14	1.73	1.41	2.22	2.06	1.91	2.10	1.97	2.09	-	-	1.27	1.46	-	-	-	1.99
Fresh Hard	Mt	-	-	-	-	-	0.172	-	0.601	1.475	1.311	0.636	0.171	-	-	-	-	4.365
- Grade (Au)	g/t	-	-	-	-	-	2.91	-	2.32	2.13	2.46	3.33	4.14	-	-	-	-	2.54
Total	**Mt**	**0.015**	**0.153**	**1.793**	**2.695**	**2.069**	**1.153**	**1.910**	**1.407**	**1.900**	**1.311**	**0.636**	**0.327**	**0.026**	**-**	**-**	**-**	**15.393**
Grade (Au)	**g/t**	**1.76**	**1.44**	**1.44**	**2.20**	**2.05**	**2.06**	**2.10**	**2.11**	**2.12**	**2.46**	**3.33**	**2.78**	**1.43**	**-**	**-**	**-**	**2.12**
Processing																		
Oxide Ore	Mt	-	-	0.362	0.059	0.029	0.024	0.000	0.023	-	-	0.016	0.158	0.003	0.000	0.261	-	0.937
- Grade (Au)	g/t	-	-	2.08	2.93	2.70	1.59	1.33	1.40	-	-	1.15	1.13	1.05	0.75	0.70	-	1.56
Fresh Ore	Mt	-	-	0.738	1.141	1.171	1.057	1.200	0.781	0.244	0.176	0.587	0.691	1.034	1.200	0.071	-	10.091
- Grade (Au)	g/t	-	-	1.92	3.46	2.98	2.17	2.83	2.16	3.01	1.16	1.08	1.00	0.73	0.69	0.67	-	1.99
Fresh Hard	Mt	-	-	-	-	-	0.118	-	0.396	0.956	1.024	0.597	0.350	0.163	-	0.761	-	4.365
- Grade (Au)	g/t	-	-	-	-	-	3.82	-	3.09	2.80	2.95	3.54	2.60	0.95	-	0.70	-	2.54
Total	Mt	**-**	**-**	**1.100**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.200**	**1.093**	**-**	**15.393**
Grade (Au)	g/t	**-**	**-**	**1.97**	**3.44**	**2.97**	**2.32**	**2.83**	**2.45**	**2.84**	**2.68**	**2.30**	**1.48**	**0.76**	**0.69**	**0.70**	**-**	**2.12**
Construction borrow	Mt	1.012	3.455	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.467
Waste movement	Mt	-	0.647	9.849	13.027	16.431	17.347	16.590	17.093	12.316	6.262	3.143	1.435	0.060	-	-	-	114.200
Ore movement	Mt	-	0.103	1.793	2.695	2.069	1.153	1.910	1.407	1.900	1.311	0.636	0.327	0.026	-	-	-	15.329

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Total material movement	**Mt**	**1.012**	**4.205**	**11.642**	**15.721**	**18.500**	**18.500**	**18.500**	**18.500**	**14.216**	**7.573**	**3.779**	**1.761**	**0.086**	**-**	**-**	**-**	**133.995**

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Stockpile reclaim	Mt	-	-	0.103	-	0.209	0.525	0.052	0.284	0.015	0.203	0.645	0.903	1.174	1.200	1.093	-	6.406
Operating cost	$M	-	-	25.695	33.089	40.508	42.154	44.283	44.383	41.450	27.310	18.713	12.931	5.011	3.500	3.416	1.046	343.489
Capital development	$M	3.854	11.732	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15.586
Capital equipment	$M	15.571	8.586	11.220	6.632	1.268	4.436	0.082	0.082	0.155	0.419	0.673	0.123	0.306	1.268	-	-	50.821
Total mining cost	**$M**	**19.424**	**20.318**	**36.915**	**39.721**	**41.776**	**46.590**	**44.365**	**44.465**	**41.605**	**27.729**	**19.386**	**13.054**	**5.317**	**4.767**	**3.416**	**1.046**	**409.896**
Unit operating cost	$/t rock	-	-	2.21	2.10	2.19	2.28	2.39	2.40	2.92	3.61	4.95	7.34	58.29	-	-	-	2.56
Unit capital cost	$/t rock	19.20	4.83	0.96	0.42	0.07	0.24	0.00	0.00	0.01	0.06	0.18	0.07	3.56	-	-	-	0.50
Total unit mining cost	**$/t rock**	**19.20**	**4.83**	**3.17**	**2.53**	**2.26**	**2.52**	**2.40**	**2.40**	**2.93**	**3.66**	**5.13**	**7.41**	**61.85**	**-**	**-**	**-**	**3.06**

5.1.7 Ore Reserve estimate

The key Modifying Factors used to estimate the Tulu Kapi Ore Reserve are based on the experience of Snowden and KEFI employees in this type of deposit and style of mineralisation. Section 5.11 of this report summarises the status of material aspects of the September 2014 Tulu Kapi Ore Reserve estimate, in the context of the JORC Code (2012) Table 1, Section 4 Checklist of Assessment and Reporting Criteria. Section 5.12 of this report also includes the Competent Person sign-offs for the Tulu Kapi Ore Reserve.

The Tulu Kapi Ore Reserve estimate is in accordance with the JORC Code (2012) and the Ore Reserve for the Tulu Kapi deposit as at September 2014 is summarised in Table 5.4.

Table 5.4 April 2015 Tulu Kapi Ore Reserve estimate reported above a 0.5 g/t Au cut-off grade

JORC (2012) Reserve category	Cut-off (g/t Au)	Tonnes (Mt)	Au (g/t)	Ounces (Moz)
Probable – High grade	0.90	12.0	2.52	0.98
Probable – Low grade	0.50 to 0.90	3.3	0.73	0.08
Total		**15.4**	**2.12**	**1.05**

Note: Mineral Resources are inclusive of Ore Reserves. Numbers are reported to three significant figures. Small discrepancies may occur due to the effects of rounding.

All references to currency in this report are in United States of America dollars (“US$”).

5.2 INTRODUCTION

5.2.1 Scope of work

This report presents a mining feasibility study undertaken for the Tulu Kapi deposit. The primary objective of the mining study is to optimise the single project mining configuration in the context of the overall feasibility study, for investment opportunity. The study is premised on the February 2015 Mineral Resource estimate.

The primary measure for the project viability is the optimised net present value ("NPV") that is achieved. In a mining sense, optimal NPV is facilitated by:

- Careful consideration of the pit design to identify the valuable gold metal and subsequent production scheduling to bring forward the best possible grade early in the operation
- Optimisation of the mining lifecycle costing
- Establishment of mining risks and mitigate these risks and report any residual risks to the Ore Reserve
- To reporting of an Ore Reserve using a recognised code and internationally accepted standard.

The 2015 Tulu Kapi Ore Reserve was estimated in the context of the Australasian Code for Reporting Exploration Results, Mineral Resources and Ore Reserves, 2012 edition ("JORC Code, 2012").

The mining study included the following items:

- Applying dilution to the Mineral Resource for mining considerations
- Undertaking Whittle pit optimisations and selecting a pit staging strategy
- Preparing designs for the pit stages
- Preparing waste dump designs
- Preparing a mine layout
- Estimating the mine inventory
- Developing a mining schedule
- Preparing a period plan and developing haulage paths
- Developing run of mine ("ROM") and stockpile designs
- Estimating in-pit dewatering requirements (to the pit crest only)
- Assessment of key Ore Reserve risks
- Preparing an Ore Reserve statement.

Snowden also worked with a mining consultant as specified by KEFI Minerals Ethiopia ("KEFI") as Mining And Cost Engineering Pty Ltd ("MACE") to:

- Select suitable mining equipment
- Develop a mining cost model which includes mining related mobile plant operating and capital costs (not mining infrastructure capital).

5.2.2 Level of accuracy

The overall feasibility study that is the subject of this report is of an overall accuracy of ±10% to ±15%.

5.2.2.1 Estimating method and accuracy range

The accuracy assessment was underpinned by using proprietary software for the physicals estimation using:

- Whittle optimisation software for determining spatial limits of the pits or shells
- Datamine software for dilution application and inventory reporting
- MineSight software for pit and stage design, ROM and stockpile design, waste dump design and road layout design
- Evaluator (Snowden proprietary software) for production schedule optimisation.

The feasibility estimate was developed to present the most likely case (P_{50}).

Snowden used operating and capital costs and cost sources from MACE and compared these to:

- Previous studies for similar projects
- Comparisons and similar data
- Equipment or technology vendors
- Bulk material suppliers.

5.2.2.2 Estimate strategy

The basis of the operating cost estimate used the strategy followed as:

- Budget pricing
- Factorised costs for minor items
- Rule of thumb
- Judgmental allowances.

5.3 MINE GEOLOGY AND DILUTION APPLICATION

5.3.1 Local geology in the mining area

Local geology comprises a series of Neo-Proterozoic greenstone rocks, including meta-sediments, meta-volcanics and intrusions. Structurally, the deposit is located within a regional-scale north-northeast to south-southwest trending collision zone, comprising a series of northeast-southwest, north-south and west-southeast trending fault systems.

Host geology of the mineralisation comprises a coarse grained, mafic syenite batholith. The primary gold mineralisation is associated with albitised zones within the syenite which host narrow quartz veins. These zones dip at moderate angles to the west. A number of near-vertical dolerite dykes are also present within the syenite, trending northeast-southwest.

The eastern boundary of the deposit is formed by a diorite intrusive body. The syenite/diorite contact is reported to be faulted/sheared in some sections.

The south-eastern boundary of the deposit is defined by a northeast-southwest trending shear zone (the Bedele Shear Zone) that dips northwest at moderate angles, steepening near to surface. The shear zone comprises zones of sheared syenite and diorite with highly schistose fabric and chloritic alteration, separated by discrete, highly fractured, brittle fault structures.

Earlier studies of the deposit's structural geology interpreted a number of sets of mine-scale faults within the syenite, however the latest interpretation by KEFI has discounted their presence.

The deposit is covered by a layer of residual soil, the product of complete weathering of the bedrock. This material has thickness between about 2 m and 10 m, and the mechanical properties of an engineering soil.

Beneath the residual soil layer the bedrock has been weathered to a moderate to high degree, typically to a depth between 10 m and 40 m. This material is classified geotechnically as Moderately to Highly Weathered rock, with weathered minerals in structures and penetrating into the in-situ rock blocks.

The location of the Tulu Kapi deposit is outside the main seismic belt associated with the Rift Valley, and seismic risk is considered to be low.

5.3.2 Model preparation

5.3.2.1 Model comparison

The February 2015 resource block model (tk1501.dm) was different from the previous 2014 model because wireframes around the ore were developed using a cut-off grade of 0.3 g/t Au. This resulted in a more constrained tonnage estimate and this is compared in the 2014 and February 2015 resource block model cross-section comparison as provided in Figure 5.9 and Figure 5.10.

Figure 5.9 2014 resource model tk1501.dm section view – 1004825N

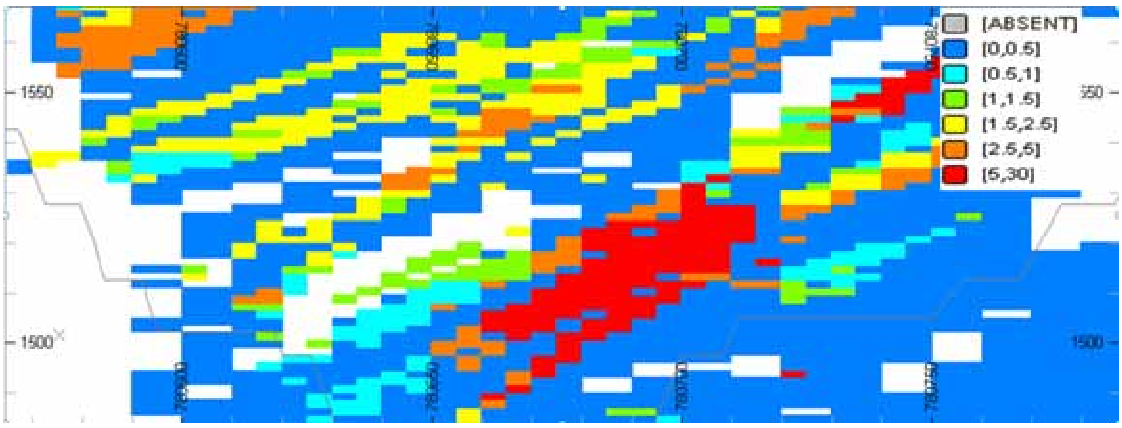


Figure 5.10 February 2015 resource model section view – 1004825N

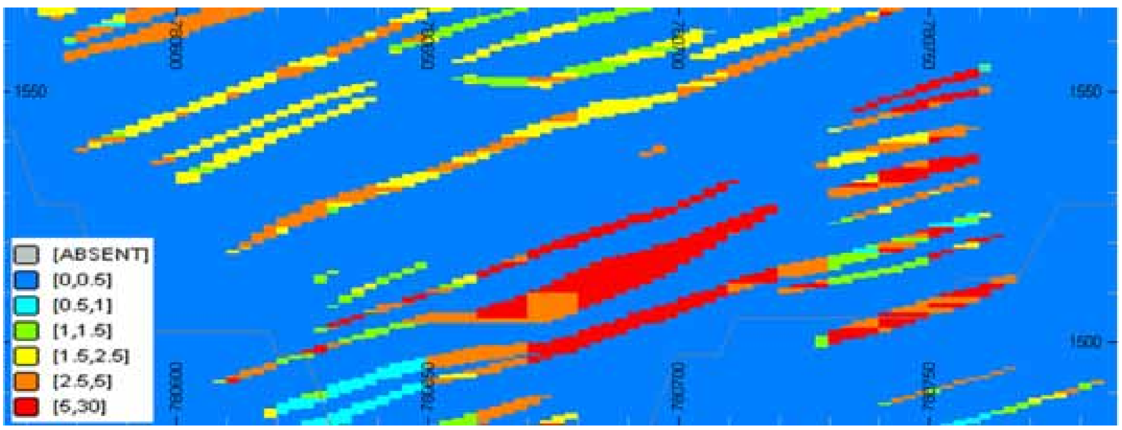


Figure 5.11 2014 resource model plan view – 1530 mRL

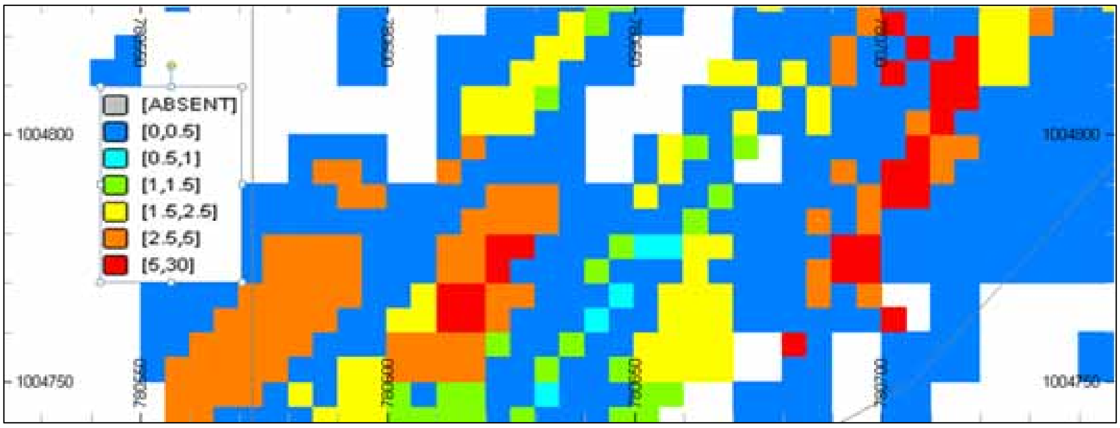
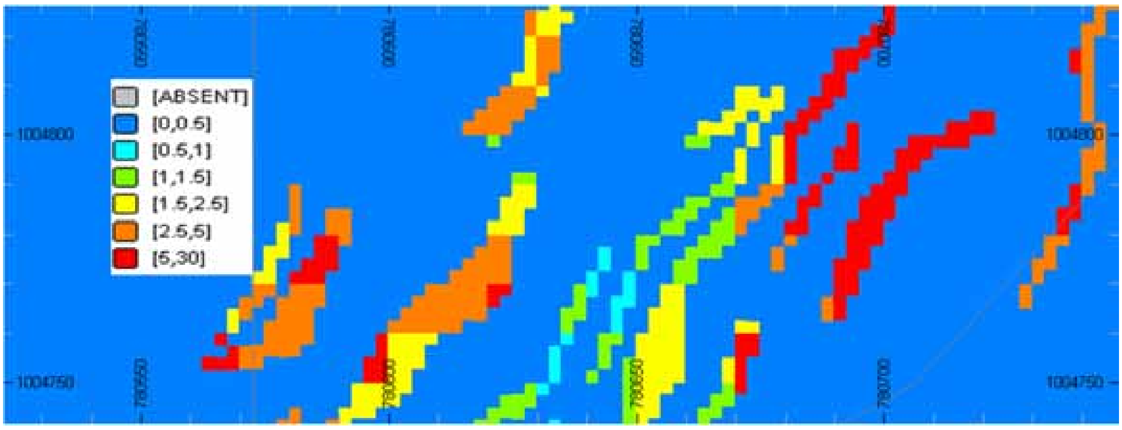


Figure 5.12 February 2015 resource model plan view – 1530 mRL



5.3.2.2 Tulu Kapi dilution and ore loss application

Snowden considered that the effect of dilution on the Tulu Kapi deposit could be potentially high in ore mining operations unless a selective mining approach is adopted. The ore-waste contact is very visual at Tulu Kapi and this will assist in reducing edge dilution. Dilution tends to increase tonnes and reduce grades, particularly on the margins of the orebody, where the mixing of low-grade or mineralised waste blocks can reduce ore block grades. On the reserve tonnage scale this can be represented for a given cut-off by a comparison of the original resource tonnes grade curve to the diluted tonnes grade curve. There is a contribution for dilution and ore loss based on:

- Operator experience
- Visual differential between ore and waste
- Grade control methods
- Blasting outcomes
- Bench size selection
- Flitch height selection
- Use of support machines, to clean ore faces and isolate the ore.

Dilution estimates are usually qualitative and, at best, semi-quantitative. Snowden considered the mining inventory would be subject to planned dilution with ore loss and also an unplanned ore loss.

5.3.2.3 Thickness histogram

The proportion of dilution is affected by orebody thickness. To understand this, Snowden reported the distribution of vertical thicknesses of the orebodies, using thickness bins as a statistical histogram.

Lode thickness was reported in-pit as vertical thickness to represent the bench geometry. This enabled the identification of the amount of tonnage that may be at risk of an ore loss. The overall result is a quantification of the percentage of lodes by vertical thickness enabling a quantitative assessment of the thin lodes.

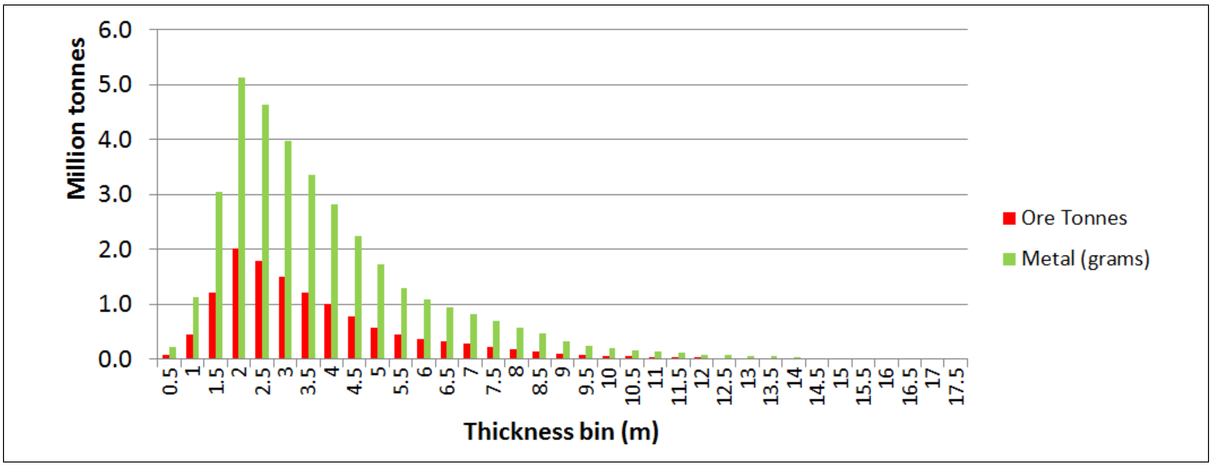
The resource tonnes were reported in the Tulu resource in-pit at a cut-off of 0.8 g/t Au; total inventory of 12.90 Mt at 2.73 g/t Au. The thickness distribution of tonnes and metal in thickness bins of 0.5 m increments is provided in Table 5.5 and graphically in Figure 5.13.

Table 5.5 Thickness bin statistics

Thickness bin	Increment		Cumulative proportion	
	Tonnes in bin (kt)	Gold metal (kg)	Tonnes	Metal
0 to 0.5	85.2	223.2	100%	100%
0.5 to 1	451.6	1,137.6	99%	99%
1 to 1.5	1,204.1	3,045.5	96%	96%
1.5 to 2	2,018.9	5,130.3	87%	88%
2 to 2.5	1,780.9	4,623.1	71%	73%
2.5 to 3	1,492.6	3,970.3	58%	60%
3 to 3.5	1,218.6	3,345.3	46%	49%
3.5 to 4	1,011.5	2,820.9	37%	40%
4 to 4.5	771.5	2,233.4	29%	32%
4.5 to 5	577.9	1,717.8	23%	26%
5 to 5.5	448.5	1,289.6	19%	21%
5.5 to 6	372.6	1,090.1	15%	17%
6 to 6.5	315.0	939.5	13%	14%
6.5 to 7	275.9	818.8	10%	11%
7 to 7.5	227.5	686.1	8%	9%
7.5 to 8	184.5	577.6	6%	7%
8 to 8.5	148.7	479.4	5%	6%
8.5 to 9	105.1	326.8	4%	4%
9 to 9.5	81.5	250.0	3%	3%
9.5 to 10	66.9	196.0	2%	3%
10 to 10.5	51.8	156.1	2%	2%
10.5 to 11	45.7	132.5	2%	2%
11 to 11.5	37.9	116.9	1%	1%

Thickness bin	Increment		Cumulative proportion	
	Tonnes in bin (kt)	Gold metal (kg)	Tonnes	Metal
11.5 to 12	27.3	81.3	1%	1%
12 to 12.5	23.5	76.4	1%	1%
12.5 to 13	16.7	49.9	0%	1%
13 to 13.5	16.2	48.3	0%	0%
13.5 to 14	9.8	27.8	0%	0%
14 to 14.5	7.7	20.1	0%	0%
14.5 to 15	6.2	16.8	0%	0%
15 to 15.5	2.7	6.3	0%	0%
15.5 to 16	2.7	7.3	0%	0%
16 to 16.5	1.4	4.0	0%	0%
16.5 to 17	0.6	1.5	0%	0%
17 to 17.5	0.9	2.7	0%	0%

Figure 5.13 Tonnes and gold metal histogram for thickness



Snowden concluded the following from the thickness investigation:

- That the mean vertical thickness was between 3.0 m and 3.5 m
- Half of the ounces are contained in lodes of greater than 3.5 m vertical thickness
- 70% of the tonnes are found in lodes of vertical thickness 2.5 m high or greater
- 50% of the tonnes are found in lodes of vertical thickness 3.5 m high or greater
- 8% of the tonnes are in lodes of vertical thickness 7.5 m high or greater.

Snowden considered this outcome in their overall qualitative assessment of the bench height and digging flitch selection.

5.3.2.4 Requirement for selective ore excavation cycle

Within the mining cycle there a specific requirement for excavator cleaning and re-handling of waste material that is necessary to ensure mining selectivity. It is envisaged that mining will progress across the bench from west to east when possible to avoid collapsing the ore material into the waste, as would occur if mined from east to west. The selective mining process contains seven steps as:

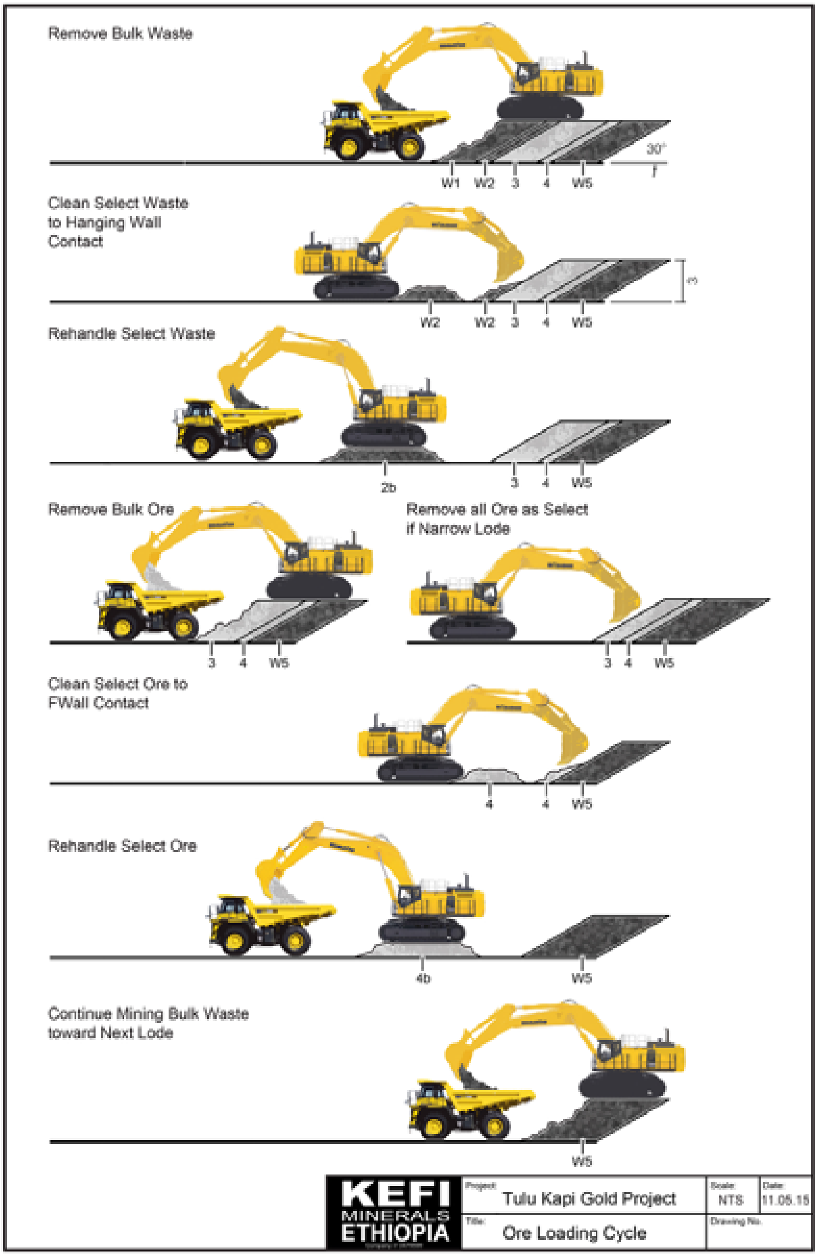
- Bulk waste removal
- Cleaning waste from the hangingwall contact
- Re-handling of selective waste
- Removal of bulk ore
- Cleaning of selective ore to the footwall contact
- Re-handling of select ore
- Continue mining the waste material.

The cycle utilises more productive top loading of trucks 3 m above the bench where trucks traverse, however the excavator needs to be on the same level as the trucks when:

- Removing waste less than 1 m thick from the ore on the western lode contact
- Moving final ore from waste on the eastern lode contact when the ore is less than 1 m thick
- When bottom loading of trucks that may be necessary when handling the windrows created from the above two activities.

For ore lodes greater than 2 m wide, the excavator will be able to resume top loading activities. The selective mining cycle is shown graphically in Figure 5.61.

Figure 5.14 Tulu Kapi selective mining cycle



5.3.2.5 Dilution model

For the planned dilution and ore loss, a method was used to simulate skin dilution using a Datamine macro to "expand" regularised resource blocks by a skin thickness, and calculate the diluted grade in the expanded blocks. A diluted grade block model is then generated.

The resource block model had the block size attributes as summarised in Table 5.6 and this model was regularised according to the dimensions in the table.

Table 5.6 Block sizes

	Easting (X)	Northing (Y)	Elevation (Z)
Parent block size (m)	10	10	1
Minimum sub-cell size (m)	2.5	2.5	0.5
Dilution regular block size (m)	2.5	2.5	0.5

The regularisation of the resource block model did not contribute to the dilution or ore loss because there was no departure from minimum sub-cell block size and larger blocks were simply divided into the smaller block size with the grade being the same as the parent block.

The macro re-estimated the grade of a diluted block using the vertical neighbouring in-situ blocks. The upper and lower in-situ block grades were added to the in-situ grade of the block being diluted with the diluted grade, being the average of the three contributing resource block grades.

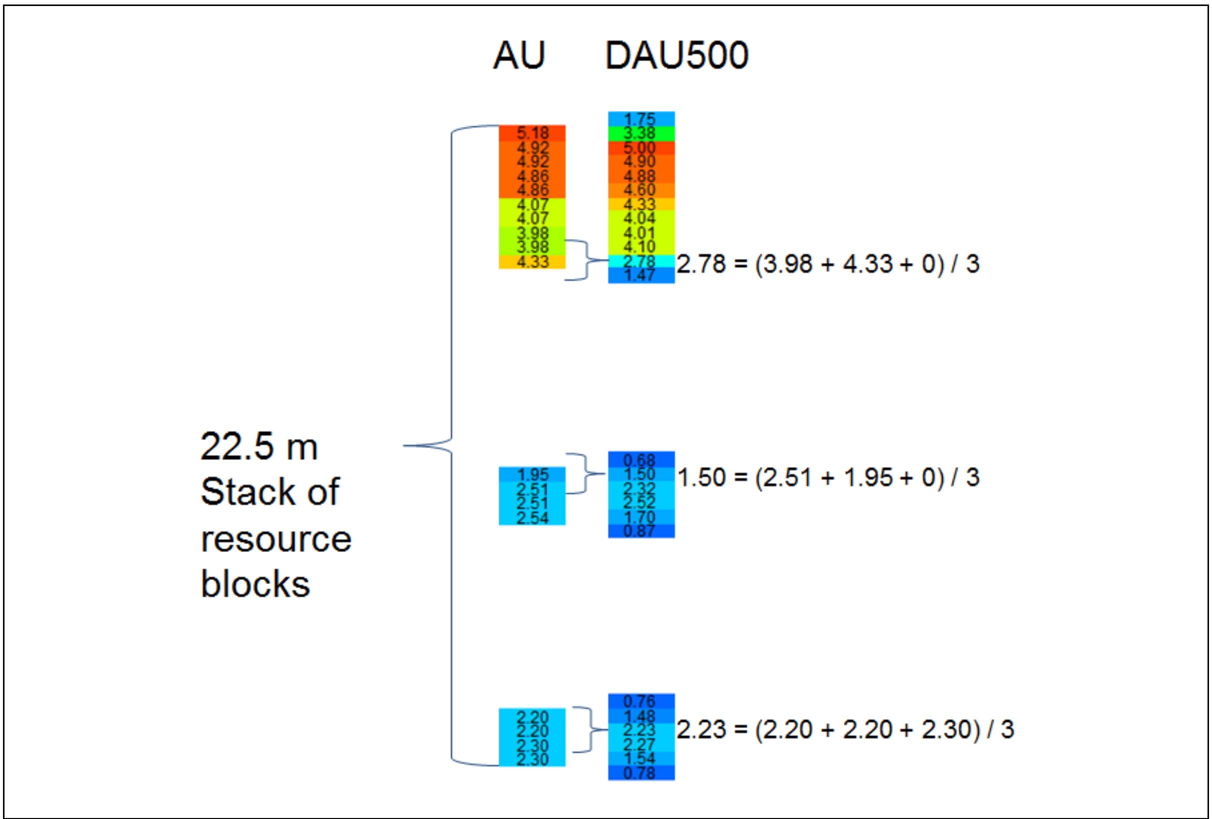
The diluting expression is further demonstrated in Equation 5.1 for the diluted ore block grade (DAU500).

Equation 5.1

DAU500 = (Au + Au (above) + Au (below))/3

A graphical demonstration of the dilution is provided in Figure 5.15. A 22.5 m vertical stack of Indicated resource blocks with the unclassified and waste blocks in between ore zones that are void of grade (as only Indicated material provides supporting grade to the diluted block) is shown.

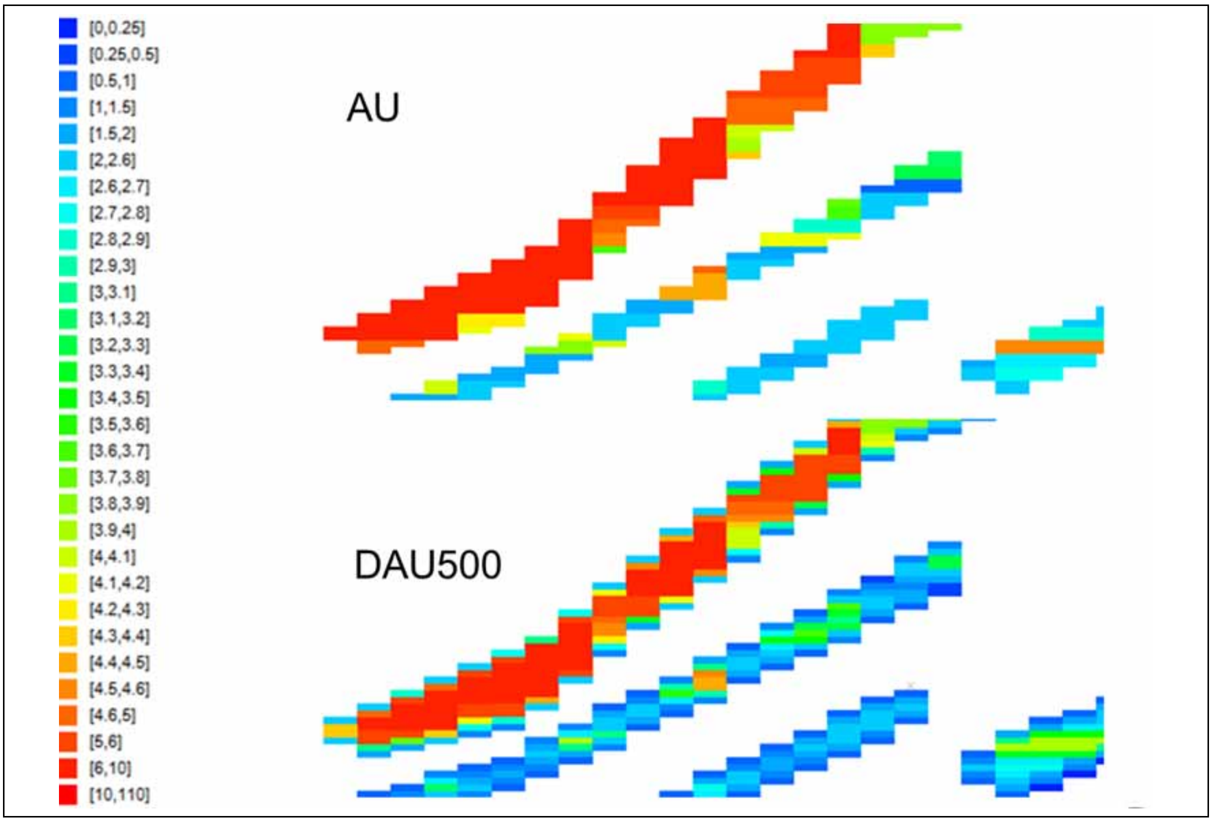
Figure 5.15 Graphical demonstration of skin dilution on section 1004950 N



The additional diluted blocks in the DAU500 stack come into existence because a zero or low grade block combined with an adjacent grade block in the AU resource stack will result in a diluted block that will have some grade. The new diluted blocks receive the same resource classification of the adjacent resource blocks. Spatially this happens because of the mechanical mixing processes associated with mining, i.e. blasting and bucket interaction at the face so that the resource classified tonnes are physically spread out.

A comparison of the resource model blocks with the diluted model TKDLWHF.dm is shown in Figure 5.16.

Figure 5.16 Comparison of the resource and diluted blocks showing included dilution blocks (1004950 N)



The in-pit ore tonnage and grades for the 2015 resource model and the diluted model are compared in Figure 5.17, with the cut-off grade provided on the curve and a cut-off of 0.9 g/t Au coloured orange. At low cut-offs the ore is smeared as there are few additional ore tonnes below a cut-off of 0.6 g/t Au.

Figure 5.17 Tonnage and grade curves for diluted and undiluted models

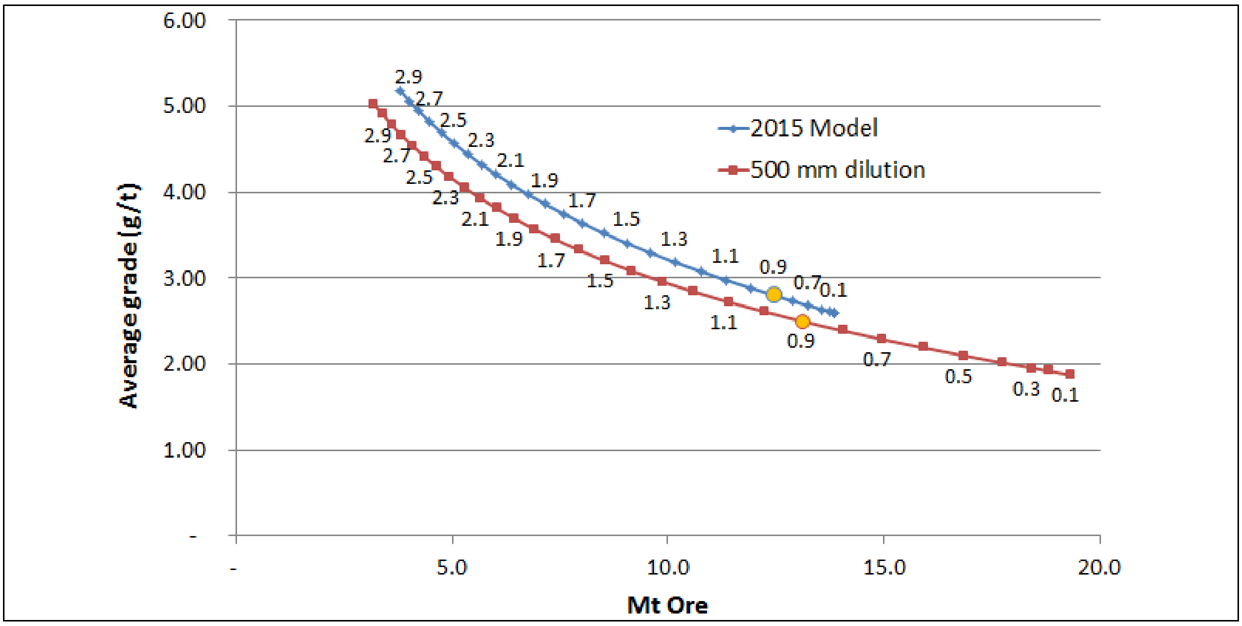


Table 5.7 2015 resource block model and diluted model (Indicated material only)

Cut-off grade (g/t Au)	2015 resource block model			500 mm diluted input model			Variance of diluted and 2015 resource block models		
	Tonnes (Mt)	Grade (g/t Au)	Contained metal (koz)	Tonnes (Mt)	Grade (g/t Au)	Contained metal (koz)	Tonnes	Grade	Contained metal
0.1	13.86	2.59	1,152	19.32	1.87	1,162	39%	-28%	1%
0.2	13.86	2.59	1,152	18.81	1.92	1,160	36%	-26%	1%
0.3	13.86	2.59	1,152	18.44	1.95	1,157	33%	-25%	0%
0.4	13.84	2.59	1,152	17.75	2.01	1,149	28%	-22%	0%
0.5	13.74	2.61	1,151	16.85	2.10	1,136	23%	-20%	-1%
0.6	13.55	2.63	1,147	15.92	2.19	1,120	17%	-17%	-2%
0.7	13.25	2.68	1,141	14.97	2.29	1,100	13%	-15%	-4%
0.8	12.90	2.73	1,133	14.05	2.39	1,078	9%	-13%	-5%
0.9	12.44	2.80	1,120	13.12	2.49	1,053	6%	-11%	-6%
1.0	11.92	2.88	1,105	12.24	2.61	1,026	3%	-10%	-7%
1.1	11.34	2.98	1,085	11.40	2.72	997	1%	-9%	-8%
1.2	10.76	3.08	1,064	10.60	2.84	968	-1%	-8%	-9%
1.3	10.17	3.18	1,041	9.87	2.96	938	-3%	-7%	-10%
1.4	9.59	3.29	1,015	9.18	3.08	908	-4%	-7%	-11%
1.5	9.04	3.41	990	8.54	3.20	879	-6%	-6%	-11%
1.6	8.51	3.52	964	7.94	3.32	849	-7%	-6%	-12%
1.7	8.03	3.63	939	7.40	3.45	820	-8%	-5%	-13%

In the diluted model at a cut-off of 0.9 g/t Au, there was a 6% decrease in gold metal and a 6% increase in the ore tonnage. Also, in the diluted model there is equivalent ore loss of (100% – 1053/1120) = 6% and equivalent dilution of (13.12 Mt / 12.44 * (100% – 6%)) – 100% = 12% dilution.

Later prior to production scheduling, a further ore loss of 5% was considered from unplanned dilution such as variable blasting outcomes and grade misallocation or spillage, and this was applied to the mining inventory prior to scheduling.

5.4 PIT OPTIMISATION

Pit optimisations were accomplished using industry recognised Whittle software to establish the economic limits of the pit.

5.4.1 Basis of optimisation

5.4.1.1 Geotechnical slope angles

The geotechnical slope angles applied in the optimisation are summarised in Table 5.8. The angles were assessed from the design parameters in the Snowden geotechnical study (Annexure H).

Table 5.8 Geotechnical slope angles

Domain	Units	Saprolite	Weathered	Fresh			
				West	North	East	South-east
Design		-	Geotech. berm	Road	Road	Road	Road
Total stack height	m	30	30	280	280	220	130
Bench height	m	10	10	10	10	10	10
Bench slope	degrees	50	60	80	80	70	60
Geotechnical berm width	m	10	10	0	0	0	0
Geotechnical berms	m	1	1	0	0	0	0
Pit ramp width	m	0	0	21	21	21	21
Pit ramps	no.	0	0	2	2	1.6	0
Inter-ramp	degrees	40.5	47.7	55.9	55.9	50.4	42.9
Benches	no.	3	3	28	28	22	13
Berm width	no.	5.0	5.0	5.0	5.0	4.6	5.0
Overall slope	degrees	33.6	38.8	50.4	50.4	45.6	42.9

5.4.1.2 Sales parameters

The sales parameters used in the optimisation are summarised in Table 5.9.

Table 5.9 Sales parameters

Parameter	Units	Value
Gold price	US$/oz of gold produced	1,250
Selling cost	US$/oz of gold produced	5.00
Total royalties	% value of gold sold	7%
Discount rate	%	10

5.4.1.3 Processing parameters

The processing parameters used in the optimisation are summarised in Table 5.10.

Table 5.10 Processing parameters

Item	Units	Value	Value
Throughput rate	Mtpa ore	Saprolite	1.2
		Fresh soft	1.2
		Fresh hard	1.2
Process recovery	%	Saprolite	98.6*(DilAu-(0.0465*DilAu+0.0294))/DilAu
		Fresh soft	98.6*(DilAu-(0.053*DilAu+0.0193))/DilAu
		Fresh hard	98.6*(DilAu-(0.0916*DilAu+0.0056))/DilAu
Processing cut-off grade	g/t Au		0.9
Incremental ore mining cost	US$/t ore feed	All types	1.00
Processing cost	US$/t ore feed	Oxide	9.12
		Fresh soft	6.79
		Fresh hard	9.88
Administration cost and plant sample	US$/t ore feed	All types	6.24

5.4.1.4 Mining parameters

The mining parameters used in the optimisation are summarised in Table 5.11.

Table 5.11 Mining parameters

Item	Units	Value
Average mining cost	US$/t rock	3.00
Dilution	%	Incorporated in Whittle input block model
Mining loss	%	Incorporated in Whittle input block model

5.4.2 Ore definitions and recovery

Ore was defined as any sub-cell with a cut-off grade greater than or equal to 0.9 g/t Au and a resource category of Indicated or higher. A 0.9 g/t Au cut-off grade was used to target a reserve grade of 2.5 g/t Au, as requested by KEFI.

5.4.3 Optimisation model fields

Fields were added to the resource model to consider the diluted grades, the updated geotechnical data (Snowden, 2015) and the regularised Whittle block size. This model was a Datamine model called TKMODWH.dm. Other fields that were relevant to mining engineering studies are summarised in Table 5.12.

Table 5.12 Summary of mining model fields

Field	Description	Values	Comment
Au	Original gold grade g/t	-	Yes
Dilau	Diluted gold grade g/t	-	Diluted grade
Density	Density t/BCM	-	Yes
Gsector	Geotechnical domain	E N W SE N/A	Applied as wireframe solids. N/A. No solids and wireframe and probably outside pit, so not significant.
Lith	Lithology	10 20 30 40 50	10 = Footwall 20 = Eastern diorite 30 = Syenite 40 = Northern dyke swarm 50 = Southern dyke swarm From Snowden resource estimate (not used by engineers because geotechnical definitions were used)
Rescat	Resource category	1 2 3 unclassified	1 = Measured 2 = Indicated 3 = Inferred
Rzone	Rock zones	DIOR = Diorite SAPR = Saprolite SHEA = Shear Zone SYEN = Syenite	Applied as wireframe solids from Snowden geotechnical study
Weath	Weathering		30 m below topography coded as waste

5.4.4 Results

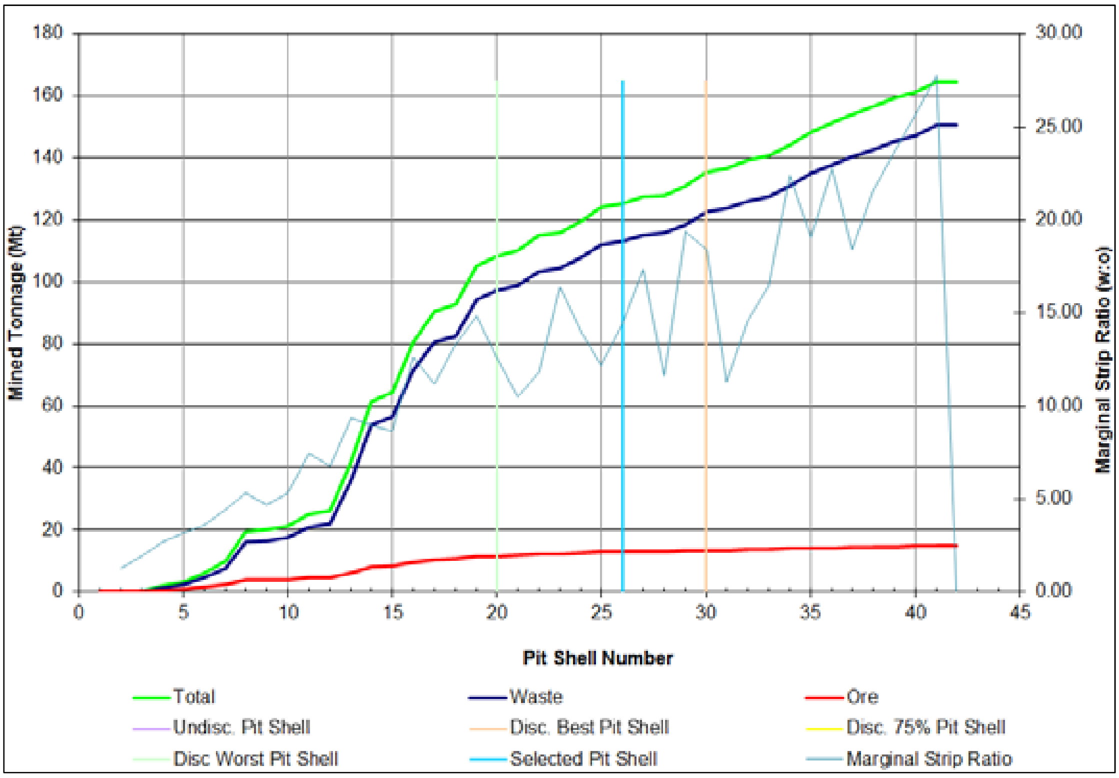
A summary of the main results are provided in Table 5.13. The optimal shell was chosen subject to commercial considerations from KEFI that included:

- The grade of the inventory as close as possible to 2.5 g/t Au
- A minimum of 10 years mine life for the ore above a 0.9 g/t Au cut-off.

Pit shell 26 was chosen as the optimal shell as this represents a shell that is bounded by the peak in cash flows for the best and worst case mining scenarios, as shown highlighted in red in Table 5.13. The worst case scenario is the case where mining may only proceed bench by bench with no multi-bench penetration allowed to access high grade ore earlier. The best case allows shell-by-shell mining thus allowing earlier access to high grade and improved cash flows, but does not consider practical mining widths.

The introduction of a staged mining approach with demonstrable access and incorporating productive mining widths allows for an improvement in the access to high grade and improved cash flows. In each pit, this is estimated to result in a 75:25 ratio of best to worst cash flow as shown in the "Disc. 75% Percentile" column of Table 5.13. The 75:25 ratio of best to worst cash flow reaches a maximum for pit shell 26. The best and worst maximum cash flows are highlighted red and the "Disc. 75% Percentile" is highlighted green. All cash flows are presented exclusive of capital cost requirements, with bank interest or taxation not considered.
Graphical results for the nested pit physicals showing the mined tonnage and the marginal strip ratio are provided in Figure 5.18, with the results for the selected pit 26 visible.

Figure 5.18 Whittle mined pit tonnage and striping ratio



The marginal strip ratio and the costs, revenue and cash flow results are provided showing marginal results, where the effect of each successive pit is calculated and are provided in Table 5.14.

Table 5.13 Whittle results (all $ are US$)

Pit shell	Revenue factor	Ore inventory (Mt)	Waste inventory (Mt)	Total inventory (Mt)	Ore processing inventory (Mt)	Ore processing gold grade (g/t)	Total costs ($M)	Gold revenue ($M)	Undisc. ($M)	Disc. worst ($M)	Disc. best ($M)	Disc. 75% percentile ($)	Strip ratio (w:o)	Ave. cost ($/t ore)	Undisc. cash flow ($/t ore)
1	0.100	0.0	0.0	0.0	0.0	6.04	0.0	0.1	0.1	0.1	0.1	0.1	0.8	22.53	188.67
2	0.150	0.0	0.0	0.0	0.0	4.58	0.3	1.8	1.5	1.5	1.5	1.5	1.3	23.05	136.64
3	0.200	0.1	0.2	0.2	0.1	3.70	1.9	10.1	8.2	8.2	8.2	8.2	1.8	24.15	104.32
4	0.250	0.5	1.4	1.9	0.5	3.22	13.1	56.8	43.7	42.0	42.0	42.0	2.5	25.72	85.95
5	0.300	0.9	2.4	3.3	0.8	3.04	22.1	87.8	65.8	61.6	61.6	61.6	2.8	26.50	79.02
6	0.350	1.5	4.7	6.1	1.4	2.80	39.6	139.1	99.5	90.1	90.2	90.2	3.1	27.60	69.37
7	0.400	2.2	7.8	9.9	2.1	2.63	60.4	191.8	131.4	115.3	116.4	116.1	3.5	28.69	62.39
8	0.425	3.7	16.0	19.5	3.6	2.51	110.5	309.0	198.5	160.2	166.2	164.7	4.3	31.07	55.82
9	0.450	3.8	16.5	20.1	3.7	2.50	113.6	316.1	202.5	162.8	169.0	167.5	4.3	31.09	55.40
10	0.475	4.0	17.5	21.3	3.8	2.48	119.9	329.6	209.7	167.4	174.3	172.6	4.3	31.25	54.65
11	0.500	4.5	21.0	25.2	4.3	2.48	138.2	367.3	229.0	179.1	187.8	185.6	4.6	32.28	53.49
12	0.525	4.7	22.0	26.4	4.4	2.47	143.7	377.8	234.1	181.7	191.1	188.8	4.7	32.48	52.92
13	0.550	6.2	36.1	41.9	5.9	2.47	210.9	499.1	288.3	207.9	224.2	220.1	5.9	36.00	49.21
14	0.575	8.1	53.7	61.5	7.7	2.47	299.8	655.9	356.2	238.5	260.9	255.3	6.6	38.77	46.07
15	0.600	8.4	56.3	64.3	8.0	2.46	312.6	677.4	364.8	240.9	264.9	258.9	6.7	39.02	45.54
16	0.625	9.6	71.6	80.7	9.2	2.49	379.1	783.5	404.4	248.7	282.5	274.1	7.4	41.37	44.14
17	0.650	10.5	80.6	90.5	9.9	2.49	421.3	848.7	427.4	254.0	292.1	282.5	7.7	42.43	43.04
18	0.675	10.6	82.6	92.7	10.1	2.50	430.2	862.0	431.8	254.8	293.9	284.1	7.8	42.71	42.87
19	0.700	11.4	94.4	105.3	10.8	2.52	481.0	935.3	454.3	257.0	302.8	291.3	8.3	44.41	41.94
20	0.725	11.6	97.3	108.4	11.0	2.52	493.7	953.0	459.3	257.1	304.8	292.9	8.4	44.68	41.57
21	0.750	11.8	98.8	110.0	11.2	2.52	500.7	962.2	461.6	257.1	305.7	293.5	8.4	44.77	41.27
22	0.775	12.2	103.4	114.9	11.6	2.51	521.7	989.5	467.8	256.6	308.0	295.1	8.5	45.17	40.50
23	0.800	12.2	104.3	115.9	11.6	2.51	525.6	994.4	468.8	256.2	308.3	295.3	8.5	45.29	40.40
24	0.825	12.5	107.8	119.6	11.8	2.50	540.7	1,012.8	472.0	254.7	309.4	295.8	8.6	45.66	39.86
25	0.850	12.8	112.0	124.1	12.2	2.49	559.5	1,034.8	475.4	253.1	310.5	296.2	8.7	45.98	39.07
26	0.875	12.9	113.0	125.2	12.2	2.49	563.9	1,039.9	476.0	252.8	310.8	296.3	8.8	46.09	38.91
27	0.900	13.0	115.2	127.5	12.4	2.49	572.6	1,049.7	477.1	251.2	311.1	296.2	8.9	46.35	38.61

Pit shell	Revenue factor	Ore inventory (Mt)	Waste inventory (Mt)	Total inventory (Mt)	Ore processing inventory (Mt)	Ore processing gold grade (g/t)	Total costs ($M)	Gold revenue ($M)	Undisc. ($M)	Disc. worst ($M)	Disc. best ($M)	Disc. 75% percentile ($)	Strip ratio (w:o)	Ave. cost ($/t ore)	Undisc. cash flow ($/t ore)
28	0.925	13.1	115.7	128.1	12.4	2.48	575.0	1,052.3	477.2	250.8	311.2	296.1	8.9	46.38	38.49
29	0.950	13.2	118.4	131.0	12.5	2.49	585.9	1,063.8	477.9	249.1	311.4	295.8	9.0	46.75	38.13
30	0.975	13.4	122.7	135.5	12.8	2.48	603.0	1,081.2	478.2	245.8	311.4	295.0	9.1	47.28	37.50

Table 5.14 Marginal strip ratio, costs revenue and cash flow for shells 11-30 (all $ are US$)

Pit shell	Ore processing inventory	Ore processing gold grade	Strip ratio			Costs							Revenue				Cash flow			% of undisc. pit shell 30		
#	Mt	g/t	Strip ratio (w:o)	Marginal strip ratio (w:o)	Change in marginal strip ratio (w:o)	Mining costs $M	Process costs $M	Selling costs $M	Total costs $M	Marginal cost $/t ore	Change in marginal cost $/t ore	Ave. cost $/t ore	Gold revenue $M	Marginal revenue $/t ore	Change in marginal revenue $/t ore	Ave. revenue $/t ore	Undisc. $M	Undisc. cash flow $/t ore	Marginal undisc. cash flow $/t ore	Total	Ore	Undisc. net cash flow
11	4.3	2.48	4.6	7.43	2.10	75.3	61.3	1.6	138.2	41.21	6.67	32.28	367.3	84.77	10.74	85.78	229.0	53.49	43.56	19%	34%	48%
12	4.4	2.47	4.7	6.75	-0.68	78.7	63.4	1.6	143.7	38.48	-2.73	32.48	377.8	74.04	-10.73	85.40	234.1	52.92	35.57	19%	35%	49%
13	5.9	2.47	5.9	9.35	2.60	124.7	84.0	2.2	210.9	46.83	8.35	36.00	499.1	84.60	10.55	85.21	288.3	49.21	37.77	31%	46%	60%
14	7.7	2.47	6.6	8.96	-0.39	183.3	113.7	2.8	299.8	47.46	0.63	38.77	655.9	83.72	-0.88	84.85	356.2	46.07	36.26	45%	61%	74%
15	8.0	2.46	6.7	8.66	-0.29	191.7	117.9	2.9	312.6	45.92	-1.54	39.02	677.4	76.79	-6.93	84.57	364.8	45.54	30.88	47%	63%	76%
16	9.2	2.49	7.4	12.61	3.95	240.6	135.1	3.4	379.1	57.72	11.80	41.37	783.5	92.08	15.29	85.51	404.4	44.14	34.36	60%	72%	85%
17	9.9	2.49	7.7	11.17	-1.44	270.1	147.5	3.7	421.3	55.04	-2.68	42.43	848.7	85.00	-7.08	85.47	427.4	43.04	29.96	67%	78%	89%
18	10.1	2.50	7.8	13.34	2.17	276.6	149.9	3.7	430.2	61.98	6.94	42.71	862.0	92.67	7.67	85.57	431.8	42.87	30.70	68%	79%	90%
19	10.8	2.52	8.3	14.80	1.46	314.6	162.4	4.0	481.0	67.01	5.03	44.41	935.3	96.67	4.00	86.35	454.3	41.94	29.67	78%	85%	95%
20	11.0	2.52	8.4	12.64	-2.16	323.9	165.7	4.1	493.7	58.22	-8.79	44.68	953.0	81.19	-15.48	86.25	459.3	41.57	22.97	80%	87%	96%
21	11.2	2.52	8.4	10.49	-2.15	328.7	167.8	4.1	500.7	52.18	-6.05	44.77	962.2	69.15	-12.04	86.04	461.6	41.27	16.98	81%	88%	97%
22	11.6	2.51	8.5	11.78	1.29	343.6	173.8	4.3	521.7	57.18	5.01	45.17	989.5	74.24	5.09	85.67	467.8	40.50	17.06	85%	91%	98%
23	11.6	2.51	8.5	16.43	4.65	346.6	174.6	4.3	525.6	70.71	13.53	45.29	994.4	88.62	14.37	85.68	468.8	40.40	17.91	86%	91%	98%
24	11.8	2.50	8.6	14.02	-2.42	357.9	178.5	4.4	540.7	64.04	-6.67	45.66	1,012.8	77.64	-10.98	85.52	472.0	39.86	13.60	88%	93%	99%
25	12.2	2.49	8.7	12.16	-1.86	371.3	183.7	4.5	559.5	57.52	-6.52	45.98	1,034.8	67.70	-9.94	85.05	475.4	39.07	10.18	92%	95%	99%
26	12.2	2.49	8.8	14.41	2.25	374.6	184.8	4.5	563.9	65.75	8.22	46.09	1,039.9	75.72	8.02	84.99	476.0	38.91	9.97	92%	96%	100%
27	12.4	2.49	8.9	17.32	2.92	381.5	186.6	4.5	572.6	72.73	6.98	46.35	1,049.7	81.40	5.68	84.96	477.1	38.61	8.68	94%	97%	100%
28	12.4	2.48	8.9	11.59	-5.74	383.2	187.3	4.5	575.0	55.82	-16.90	46.38	1,052.3	59.95	-21.45	84.87	477.2	38.49	4.13	95%	97%	100%
29	12.5	2.49	9.0	19.39	7.80	391.9	189.5	4.6	585.9	81.47	25.64	46.75	1,063.8	86.02	26.07	84.88	477.9	38.13	4.55	97%	98%	100%
30	12.8	2.48	9.1	18.40	-0.99	405.3	193.0	4.7	603.0	76.99	-4.48	47.28	1,081.2	78.75	-7.27	84.78	478.2	37.50	1.76	100%	100%	100%

Snowden assessed the selection of the pit in terms of the marginal change in moving to the next size larger pit at shell 27, and noted:

- There was a large step in the strip ratio with the extra ore and waste tonnes in pit 27 incremental strip ratio at an incremental strip ratio of 17.3. The average incremental strip was 13.1 from pit 20 to 26.
- The total cost rises from US$564M to US$573M in pit 27, however the marginal cost of this is US$72.7/t against the cost for pit 26 at US$65.8/t. However the change in the marginal cost is high for pit 26 compared to the neighbouring nested pits and in isolation this is an unfavourable cost outcome.
- There is a US$10K increase in gold revenue in pit 27, however the change in marginal revenue in pit 27 is only US$5.68/t ore compared to US$8.02/t ore in pit 26. This is a favourable revenue outcome for pit 26.
- Even though 92% of the total tonnes and 96% of the ore tonnes are mined in pit 26 compared to pit 30, almost all of the undiscounted cash flow is achieved by pit 26, indicating very low margins beyond pit 26.

Based on the above cash flow outcomes, Snowden concluded that pit 26 was a sound basis for pit design. Graphical Whittle results are provided in Figure 5.19 to Figure 5.21. Figure 5.19 shows the cash flow cases increasing with pit shell size, with the maximum cash flow inside the corresponding pit shell as identified by the vertical bar. The “selected shell” is coincident with the “discount 75% pit shell”. Figure 5.20 provides the marginal and average costs and revenues for increasing ore tonnes inside the nested shells, for all four cash flow cases. Pit shell 30 in the graph provides coincident maximum cash flows for the undiscounted and best case. Figure 5.21 shows the increasing cash flow with increasing ore tonnages for the different discount cases and the waste movement associated with processed tonnes is also graphed.

Figure 5.19 Whittle discounted cash flow pit results with pit depth penetration

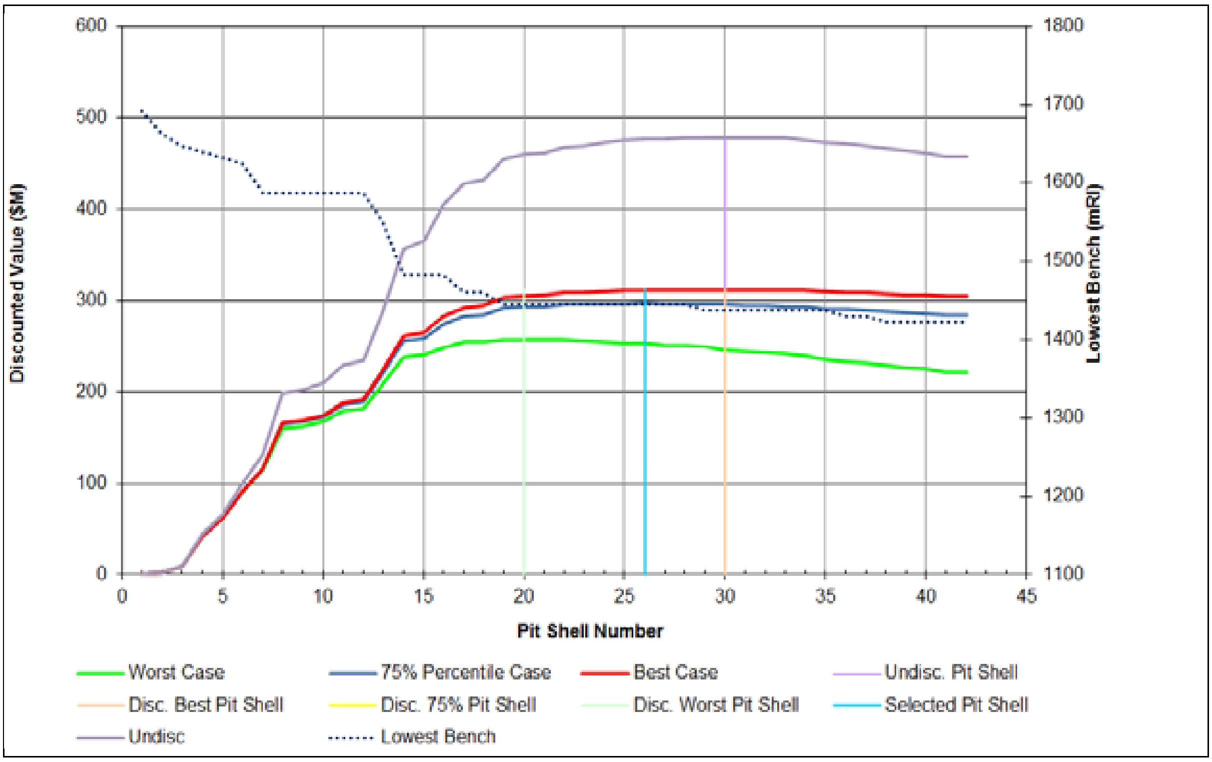


Figure 5.20 Whittle cash flow with cost and revenue results

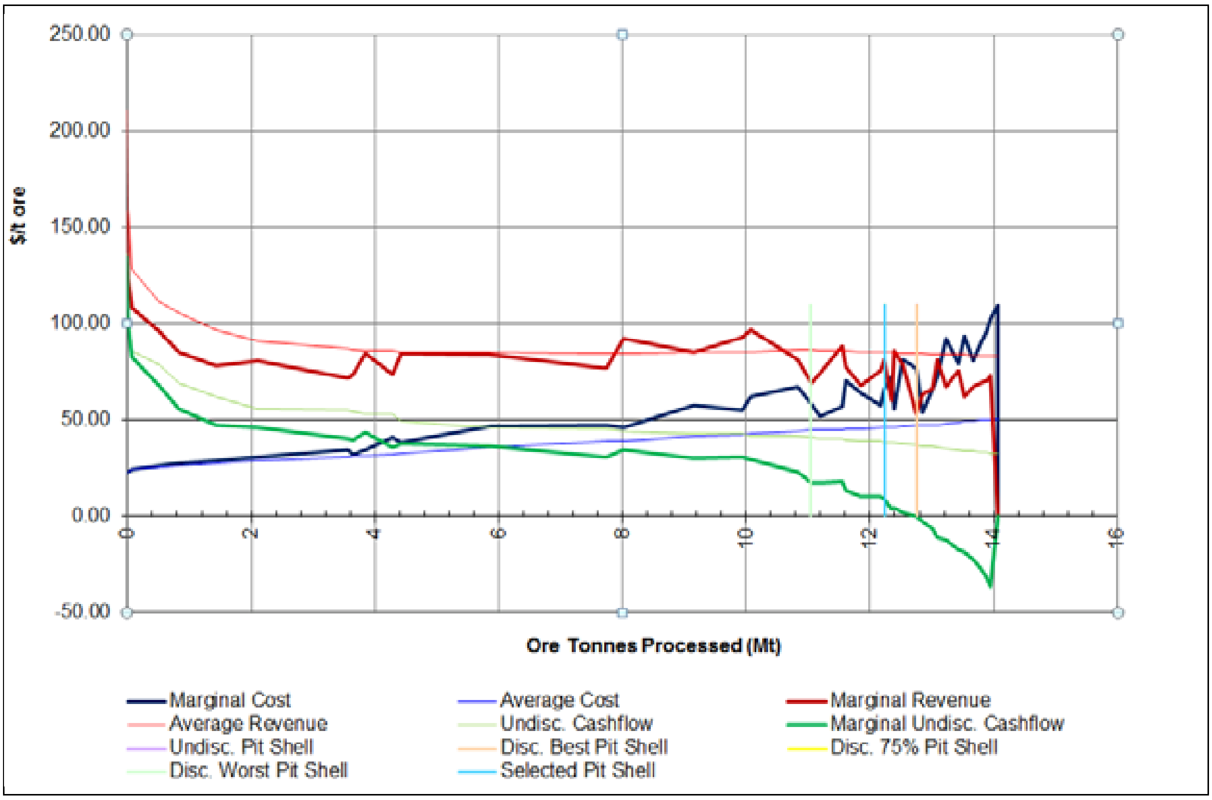
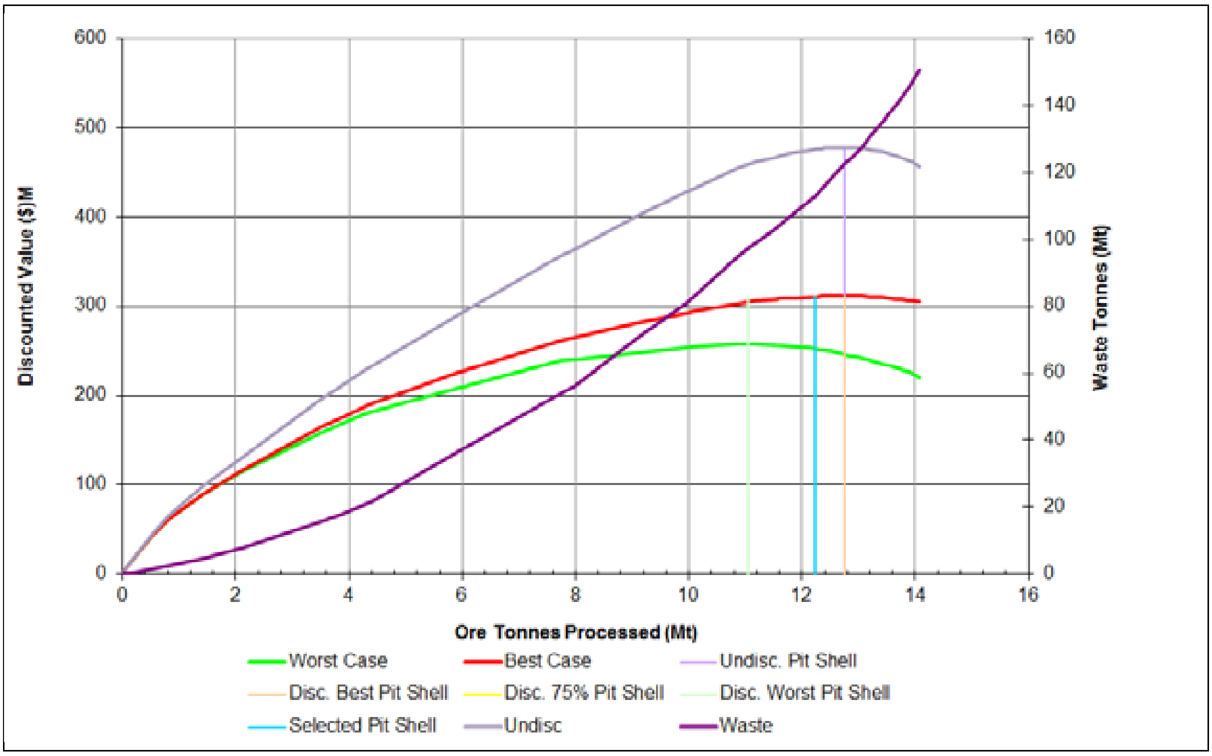
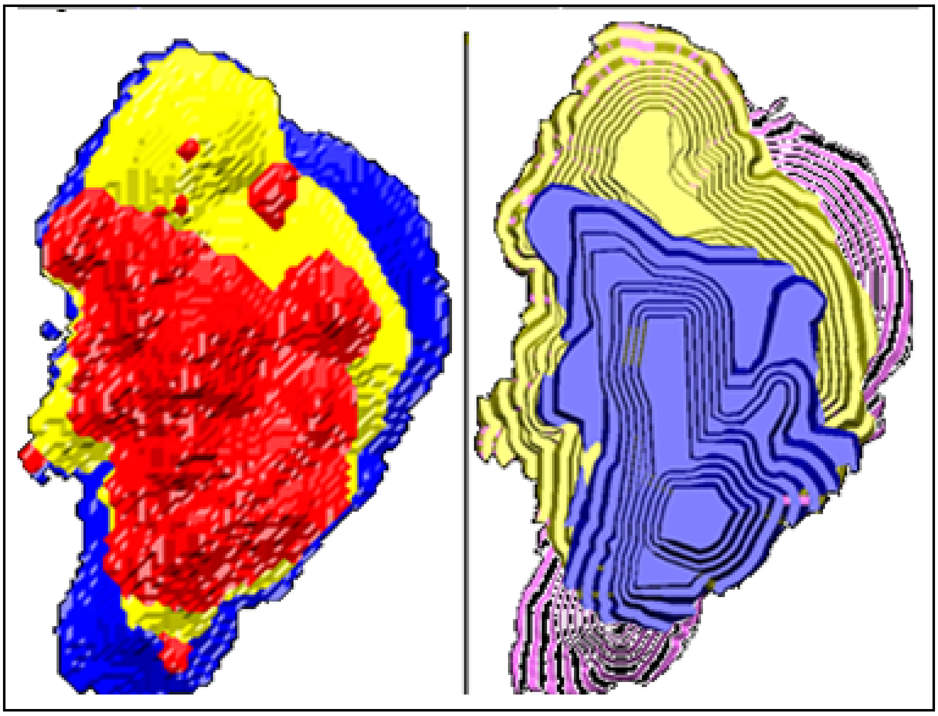


Figure 5.21 Whittle discounted cash flow results with waste tonnes



Pit shell 26 is shown in Figure 5.22 in blue with the two inner shells in red (shell 12) and yellow (shell 16) that are used as a guide for pit staging in the pit design process. The right hand image shows the expected rationalised design outcome for a pit design.

Figure 5.22 Pit shell 26 and stage shell



5.5 BASIS OF MINE DESIGN

5.5.1 Design parameters

Table 5.15 shows the design parameters used by Snowden. Further detail is given in the geotechnical section.

Table 5.15 Design parameters

Parameter	Value
Ramps	
Slope	1:10
Width	25 m
Mining	
Minimum width	50 m
Swell factor	25%
Pit slopes	See Table 5.8
Dump slopes	
Lift height	16 m
Overall slope	16.8 degrees

While a minimum mining width of 50 m was targeted, an allowance was made for tight bench corners.

5.5.2 Pre-mining construction

Figure 5.23 shows the pre-mining construction development that will use material from a quarry pit that will be mined by a separate earthmoving contractor in the infrastructure period. Operations completed in this period are independent of the mining fleet. The objectives of this period are to:

- Generate waste rock and construct initial ROM pad
- Generate waste rock to establish tailings storage facility ("TSF") dam and raw water dam
- Establish major road network
- Establish initial pit access.

Construction of the initial ROM pad is necessary for the stockpiling of pre-production ore.

A road was also established on the eastern side of the ROM pad and this remains open for the project duration.

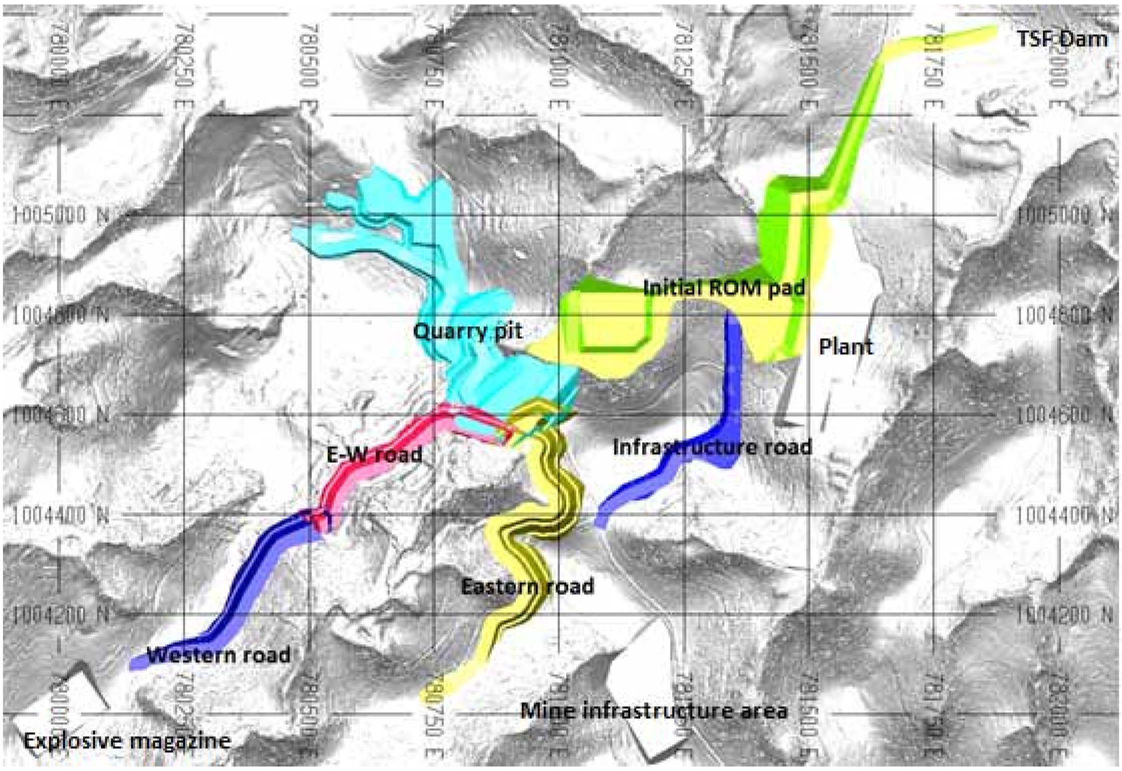
The various roads allow for access to critical locations, such as:

- The east-west road and the western road provide access to the explosive magazine
- An infrastructure road provides access from the ROM to the mine infrastructure area
- The eastern road provides access to the bottom of the south dump for the placement of waste in 16 m lifts, that is a geotechnical requirement for dumping in the south
- The ROM pad provides life of mine ("LOM") access to the TSF dam.

The quarry pit produces necessary waste rock and provides access to the top of the ridge line for mining. The required waste rock has been balanced with the cut in this period.

All of these activities are necessary before mining can commence.

Figure 5.23 Construction period



5.5.3 Pit designs

The pit designs were staged in accordance with maximising value while maintaining practical mining considerations. This section shows the individual stages; period advances are shown in the appendices.

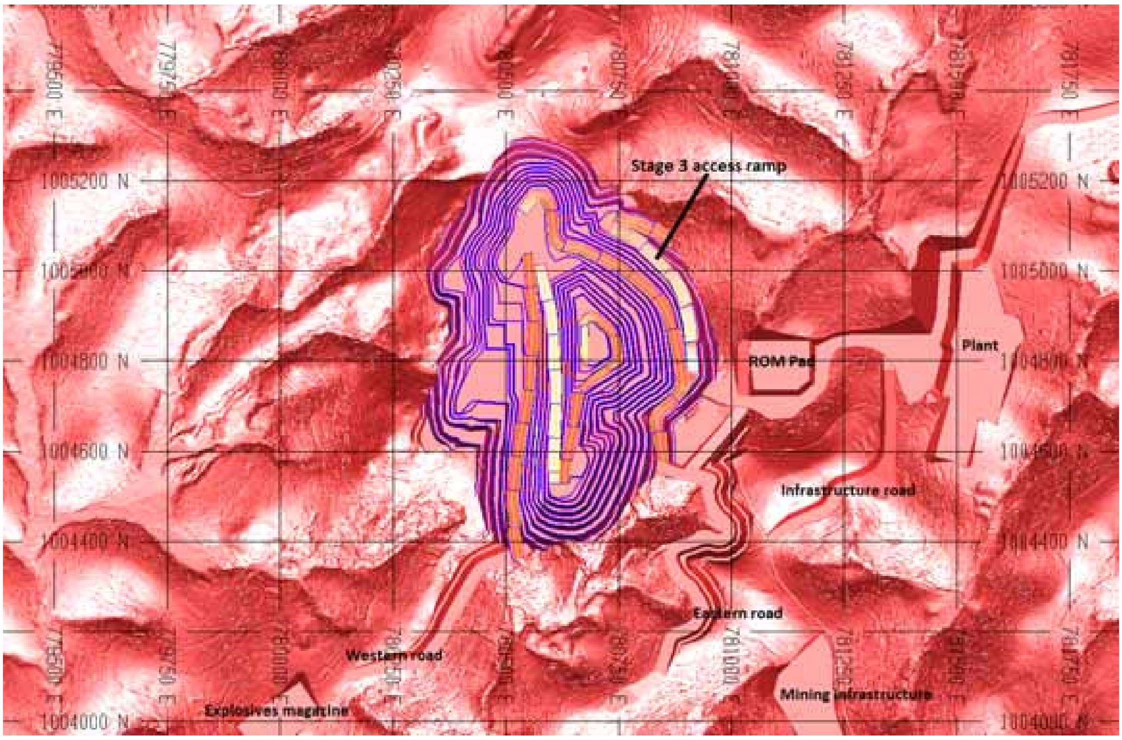
The pit stage designs in Figure 5.24 to Figure 5.29 are provided as rendered into the topographic surface at the end of the construction period. The blue design strings in the images show the respective stage.

Figure 5.24 shows pit stage 1. The Stage 2 access ramp maintains access to the top benches of Stage 2.

Figure 5.24 Stage 1

Figure 5.25 shows pit Stage 2. The Stage 3 access ramp maintains access to the top benches of Stage 3b.

Figure 5.25 Stage 2



Stage 3 has been broken into three phases as shown in Figure 5.26 to Figure 5.28. The stage was split as the top of Stage 3 has independent west and east sides, thereby allowing the production schedule to target better grade material earlier.

Figure 5.26 Stage 3a

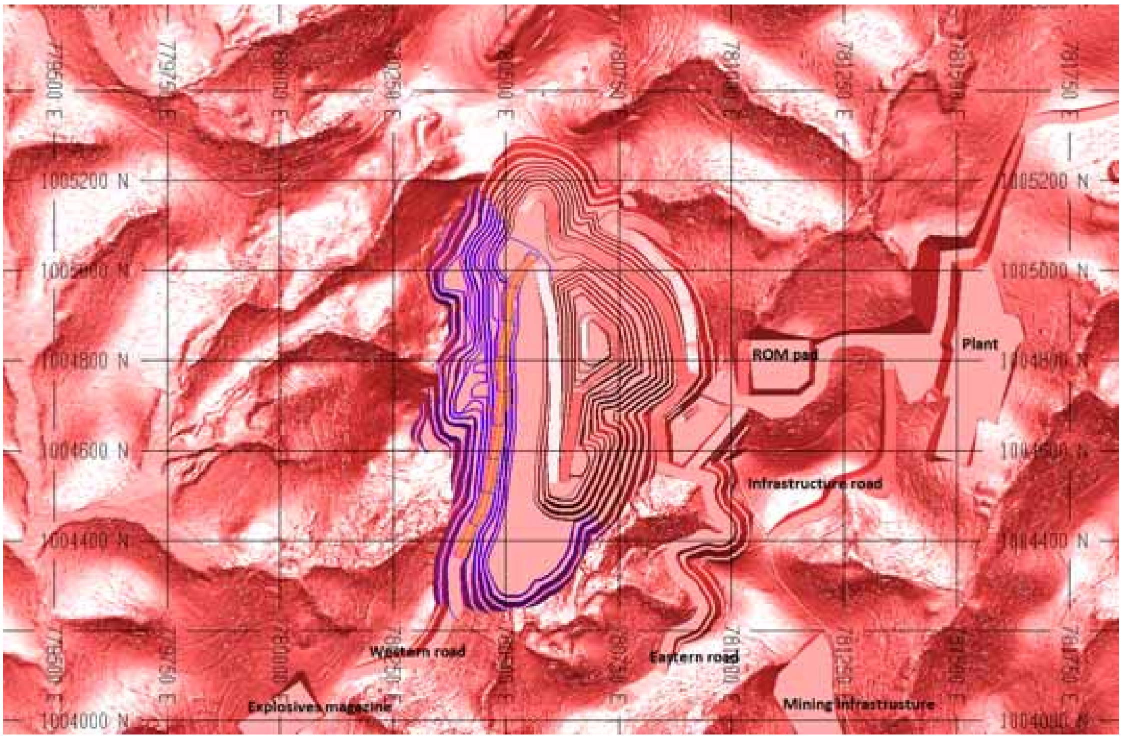


Figure 5.27 Stage 3b

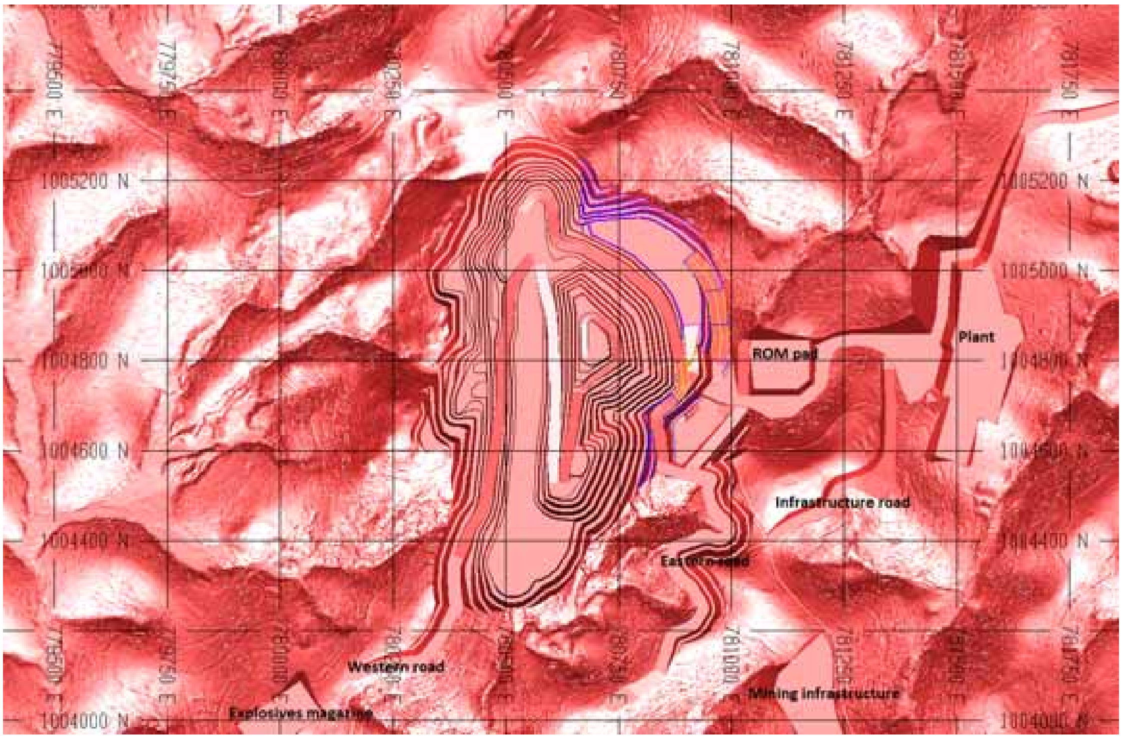
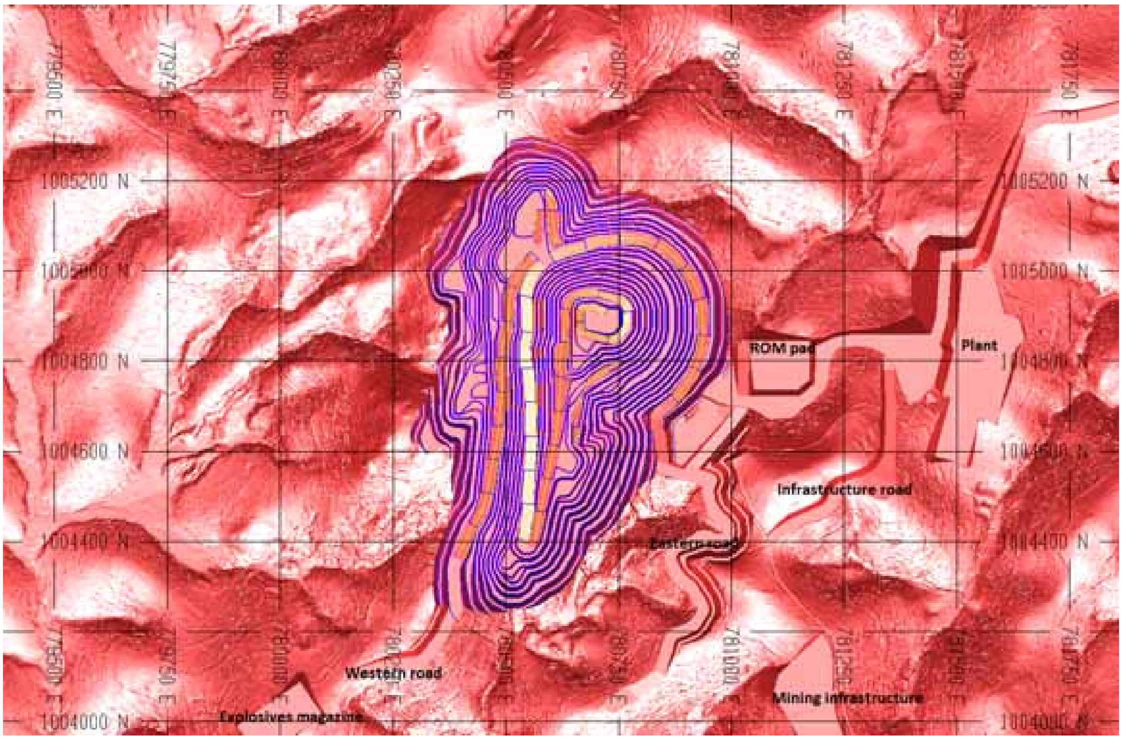
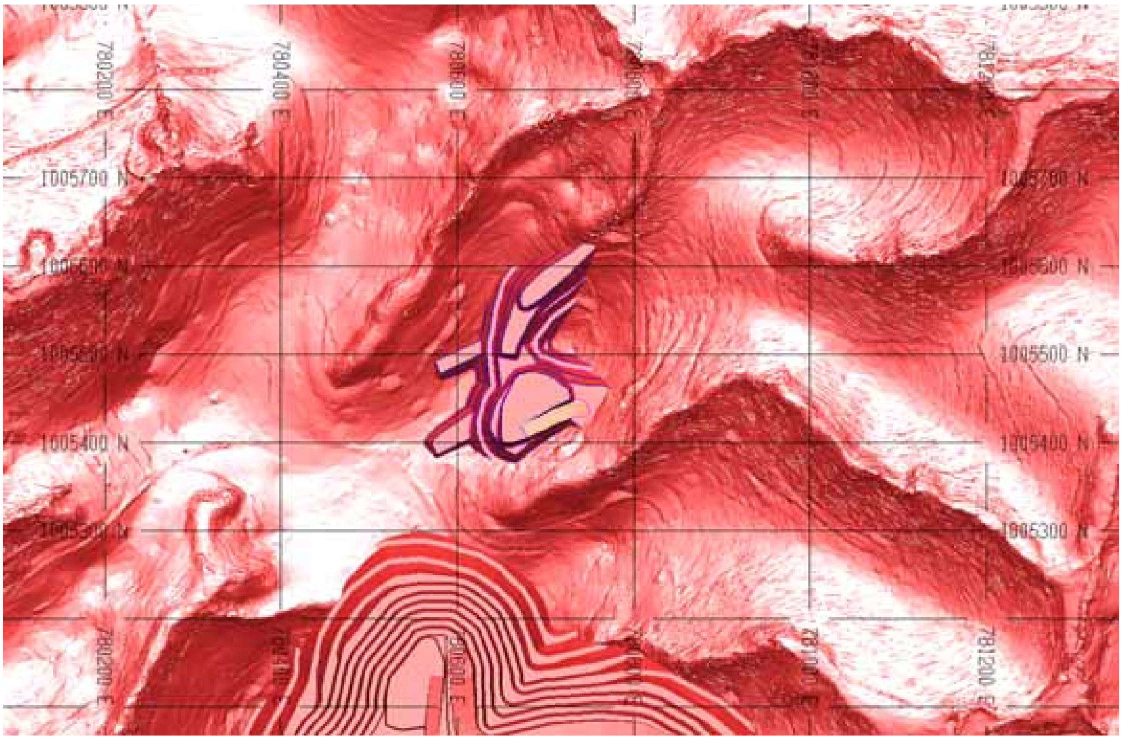


Figure 5.28 Stage 3c



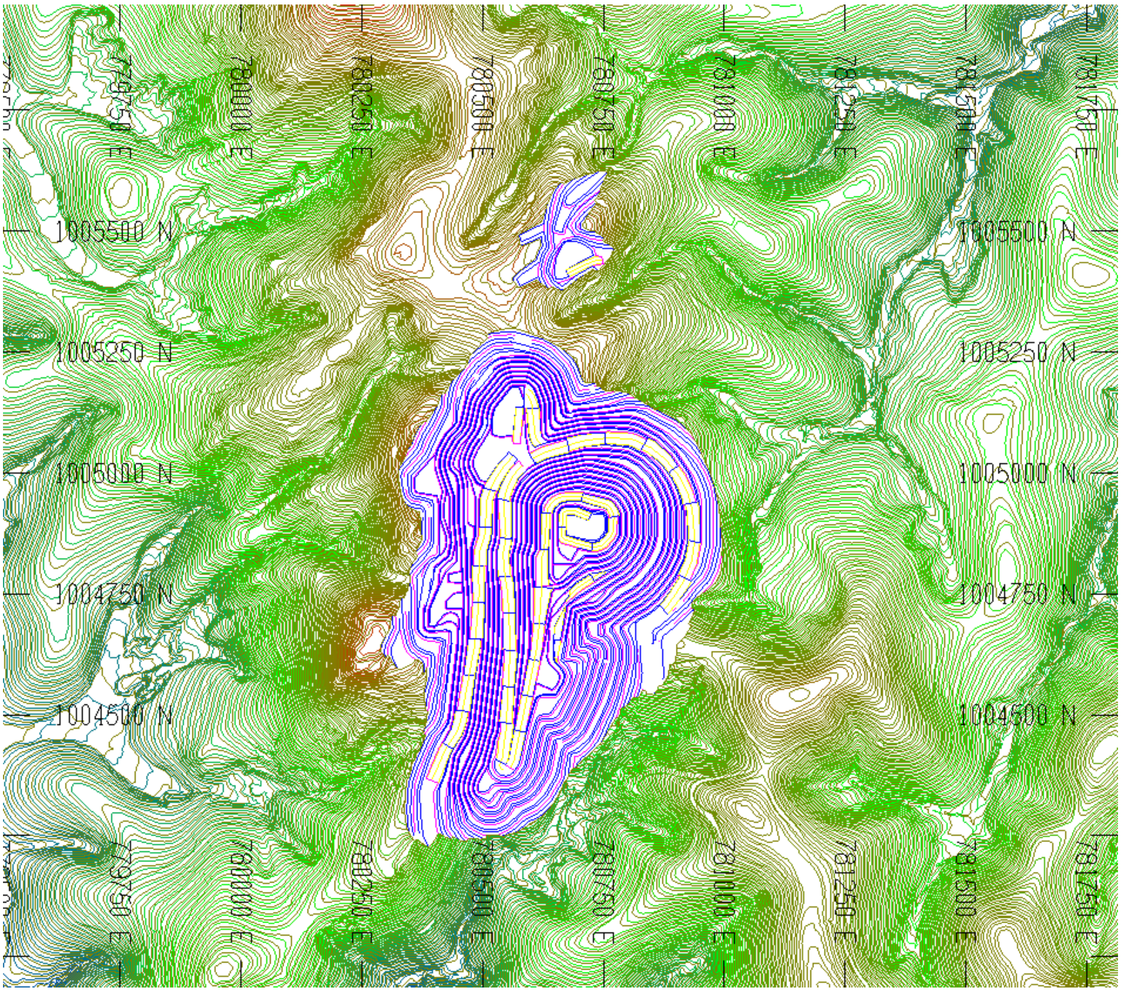
Stage 4 as shown in Figure 5.29 is a small independent stage to the north of the main pit.

Figure 5.29 Stage 4



The ultimate pit rendered to the contoured topography is provided in Figure 5.30.

Figure 5.30 Tulu Kapi pit with surrounding topography



5.5.3.1 Optimisation shell and design comparison

The comparison between the pit shell 26 and the pit design is made in Table 5.16. The quarrying phase during construction is also included and the optimisation was carried out using the original topographic surface.

Table 5.16 Comparison between the pit shell 26 and the pit design

	Total	Waste	Ore	g/t	Moz
Pit shell 26	125.2	113.0	12.2	2.49	0.98
Design pit	129.5	116.9	12.6	2.52	1.04
Quarry pit	4.7	4.6	0.0	2.17	0.00
Total pit	**134.2**	**121.5**	**12.7**	**2.52**	**1.05**
Variance	7.1%	7.5%	3.6%	1.2%	4.9%

5.5.4 Dump designs

5.5.4.1 Overall layout

Dump designs were included to the south of the pit and to the west, with a small dump north east behind the ROM pad. Figure 5.31 shows the final mining surface at the completion of the stockpile reclaim, with waste dumps, ROM pad and the ultimate pit with other non-mine infrastructure items labelled.

Figure 5.31 Final surface at completion of mining operations

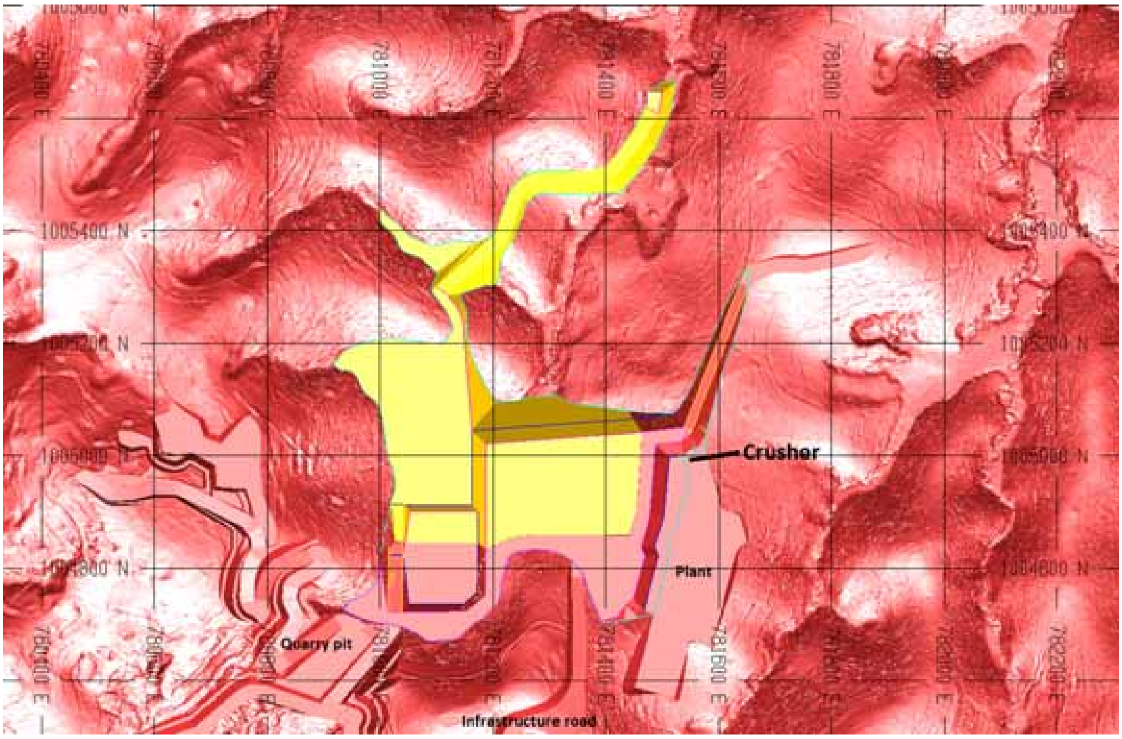
5.5.4.2 Mine development

The mine development happens after the construction period and includes the three month pre-production quarter and the life of mine ("LOM") development. Figure 5.32 to Figure 5.44 show the development of the various dumps, stockpiles and fill roads rendered into the topographic surface at the end of the construction period.

Waste dump designs and buttresses for the fill roads were designed as overall final shapes based on the recommendations in the Golder Associates report (2015) and use 16.8 degrees.

The ROM pad was broken into manageable stage developments to ensure enough time was given to generate enough waste rock for construction while having enough stockpile capacity. The initial ROM pad was established in the construction period. The second and third stage of the ROM development is shown in Figure 5.32 and Figure 5.33.

Figure 5.32 ROM pad – Stage 2



An access to the north of the Stage 2 is provided as a contingency that may eventuate for any stripping or other access.

ROM pad Stage 2 provides capacity for 2.1 MBCM of waste and is completed in Q3 of the production schedule.

For the Stage 3 ROM pad, all of the material is waste exiting from the east side of the Stage 1 and Stage 2 pits. The maximum 60 m dump face, with an average dump height of 25 m, was not formed in terraces as this dump shape is locked by the local topography. Terrace tipping was not used for the development of this dump with material being top dumped from the face of the ROM pad as the tip head advances to the north. ROM pad Stage 3 provides capacity for 6.4 MBCM of waste and is used for dumping LOM.

Figure 5.33 ROM pad – Stage 3

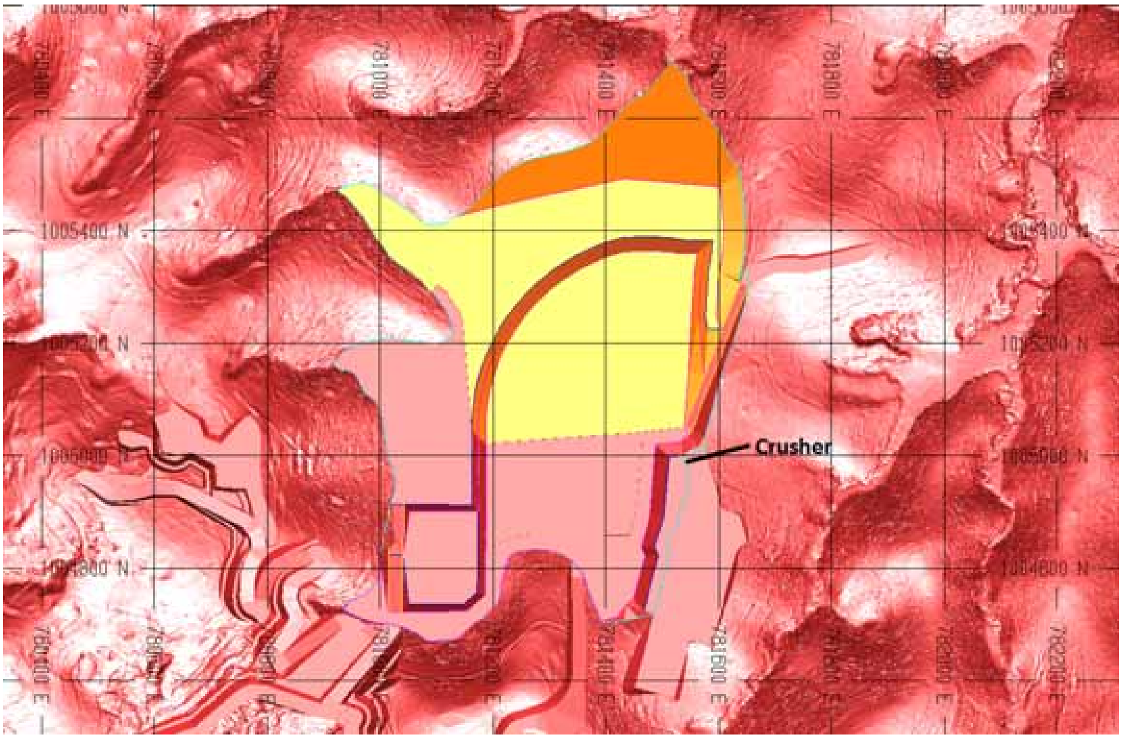


Figure 5.34 shows the skyway that is developed 10 m high above the ROM and 30 m wide. The skyway is level and necessary for dumping off, building out and managing the stockpiles. It is recommended that grade fingers be implemented, if identified after a complete grade control study is completed before production commences. The skyway is constructed from waste.

Figure 5.34 Stockpile skyway

There are two stockpiles constructed off the skyway level to accommodate volumes that are accumulated in the production schedule. The high grade stockpile shown in Figure 5.35 has a maximum capacity of 1.8 Mt and is used for ore above 0.9 g/t of gold while the low grade stockpile shown in Figure 5.36 is used for 0.5 g/t to 0.9 g/t of gold with a maximum capacity of 3.3 Mt. The high grade stockpile is 10 m high while the low grade stockpile is 30 m high.

Figure 5.35 High grade stockpile

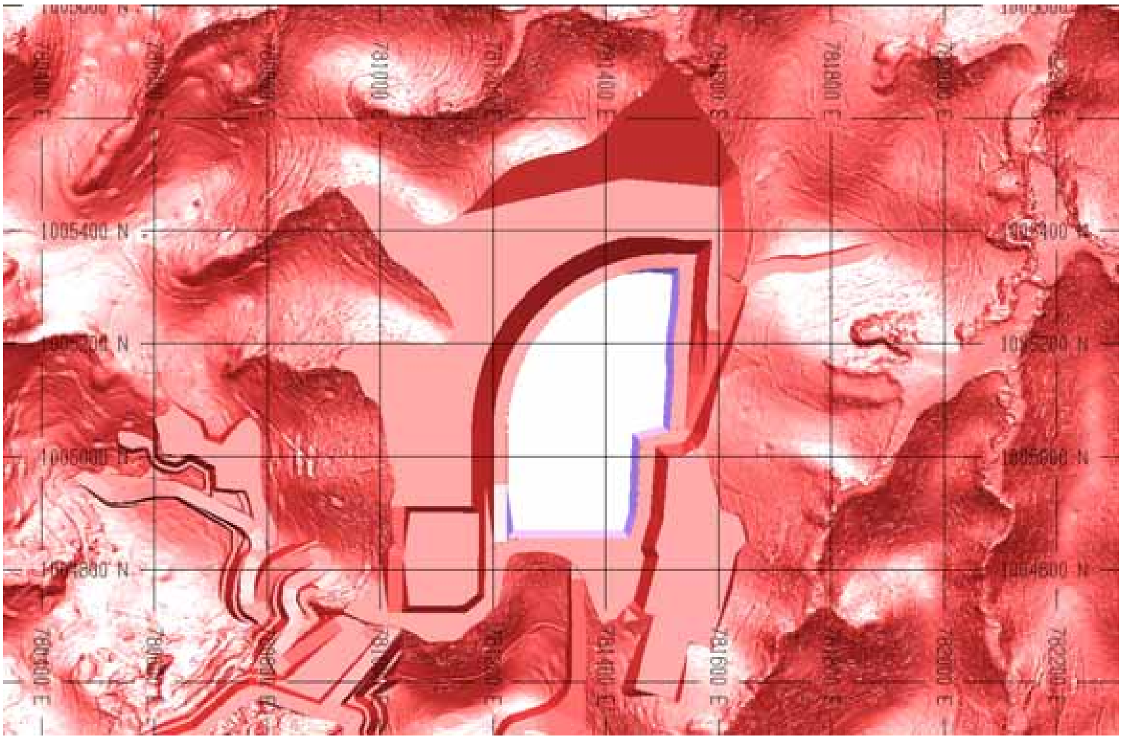
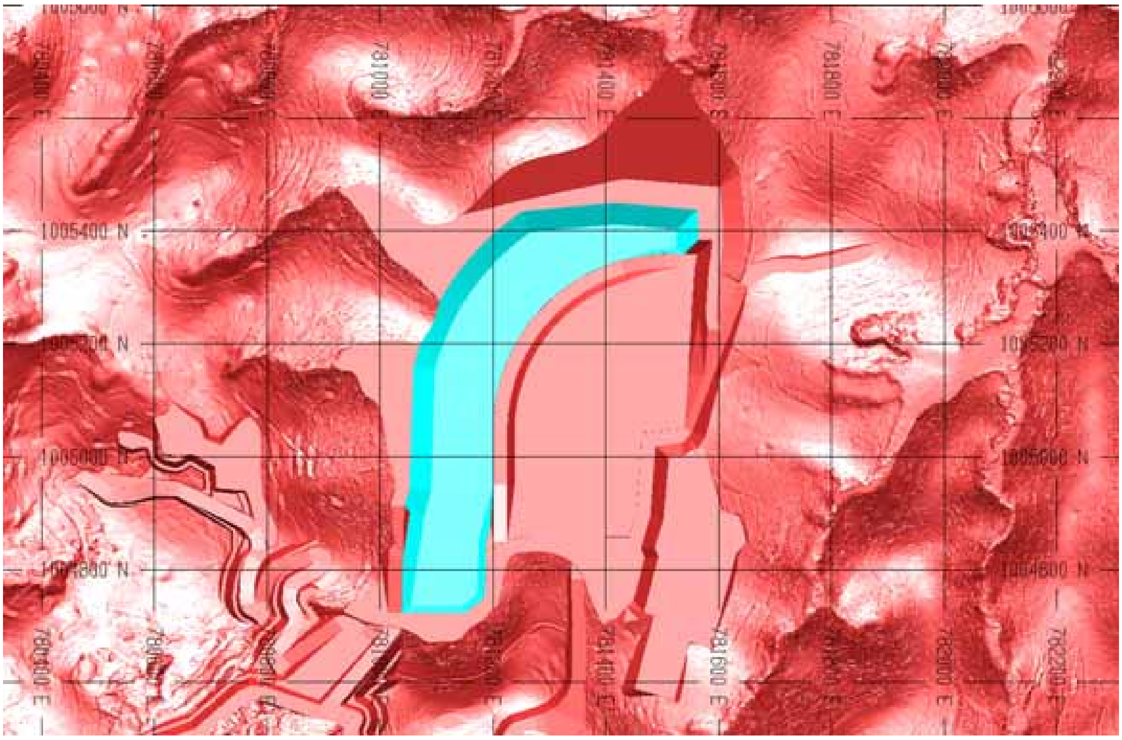
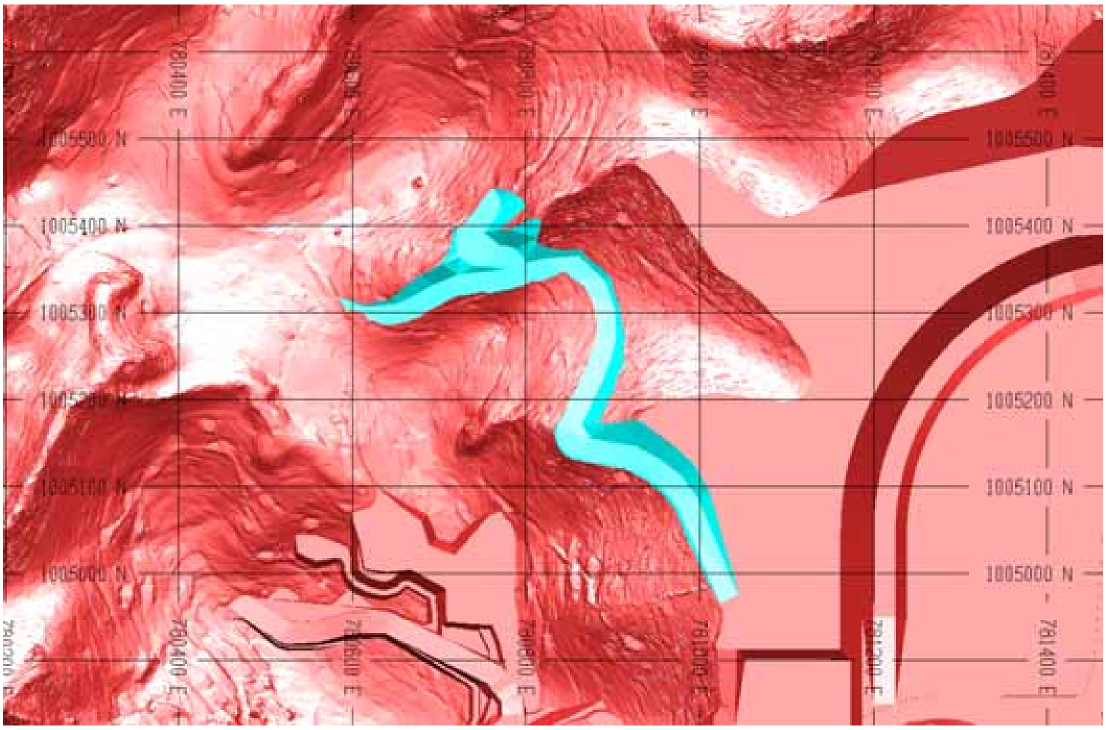


Figure 5.36 Low grade stockpile



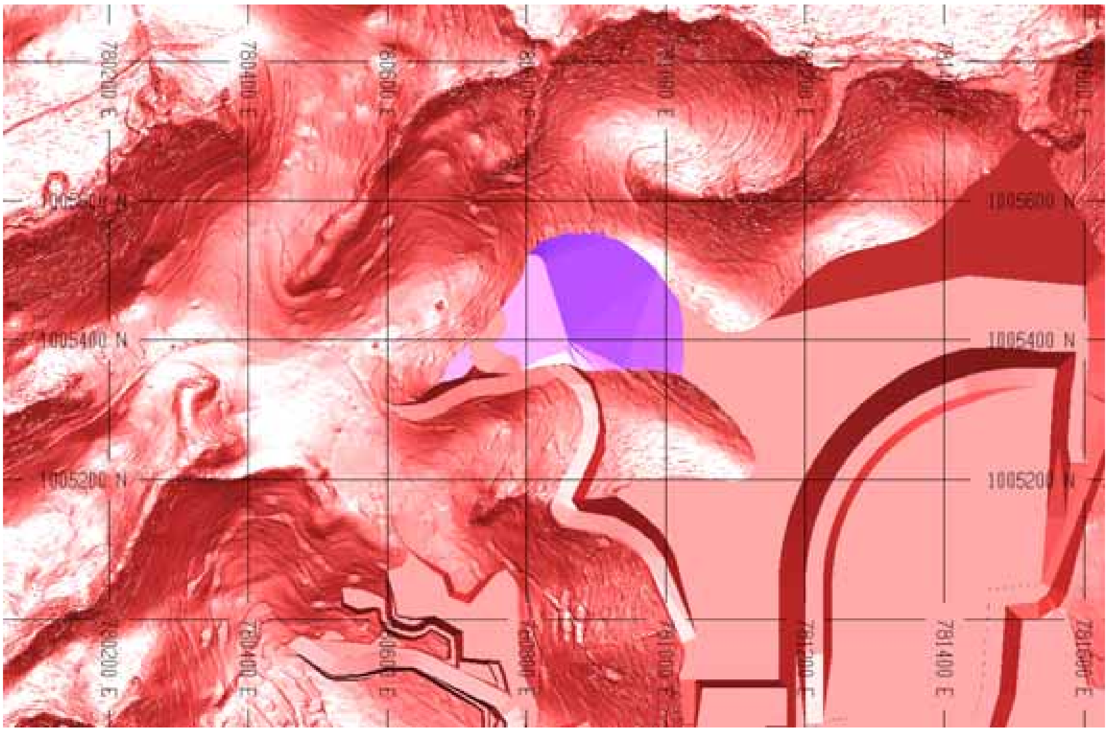
The Stage 4 access road shown in Figure 5.37 is constructed from waste extracted in the previous stages without the need for cut.

Figure 5.37 Stage 4 access road



A small dump is required to be constructed for the waste that is sourced in Stage 4 as shown in Figure 5.38.

Figure 5.38 Stage 4 waste dump



To ensure the southern and western waste dumps can be built in 16 m lifts from the bottom of the dump and stacked upwards in terraces, two access roads were designed as shown in Figure 5.39 and Figure 5.40 for east and west waste access. The "bottom up" dumping method was not necessary for the Stage 4 waste dump, due to the low dump height.

Figure 5.39 Southern dump bottom access road east

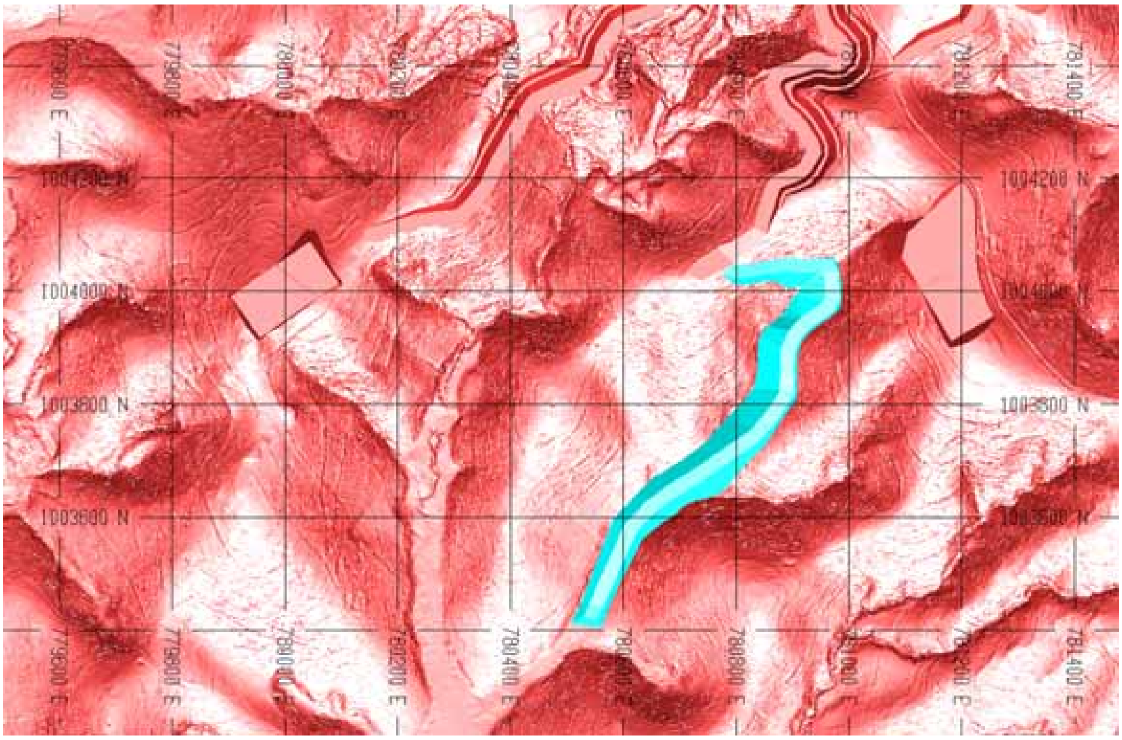
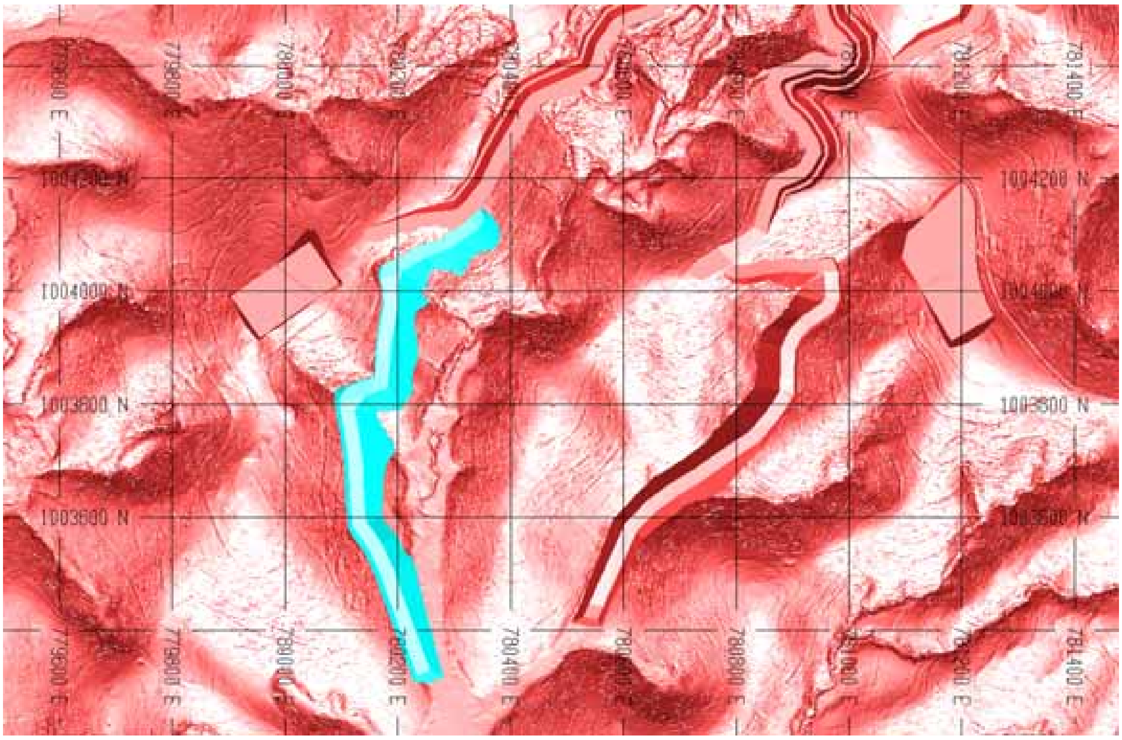


Figure 5.40 Southern dump bottom access road west



The southern dump was divided into two tiers. The bottom tier as shown in Figure 5.41 only involves downward loaded hauls whereas the top tier as shown in Figure 5.42 has upwards loaded hauls. This allows the western dump to be filled before the top tier of the southern dump and is a cheaper haul.

Figure 5.41 Southern dump bottom tier

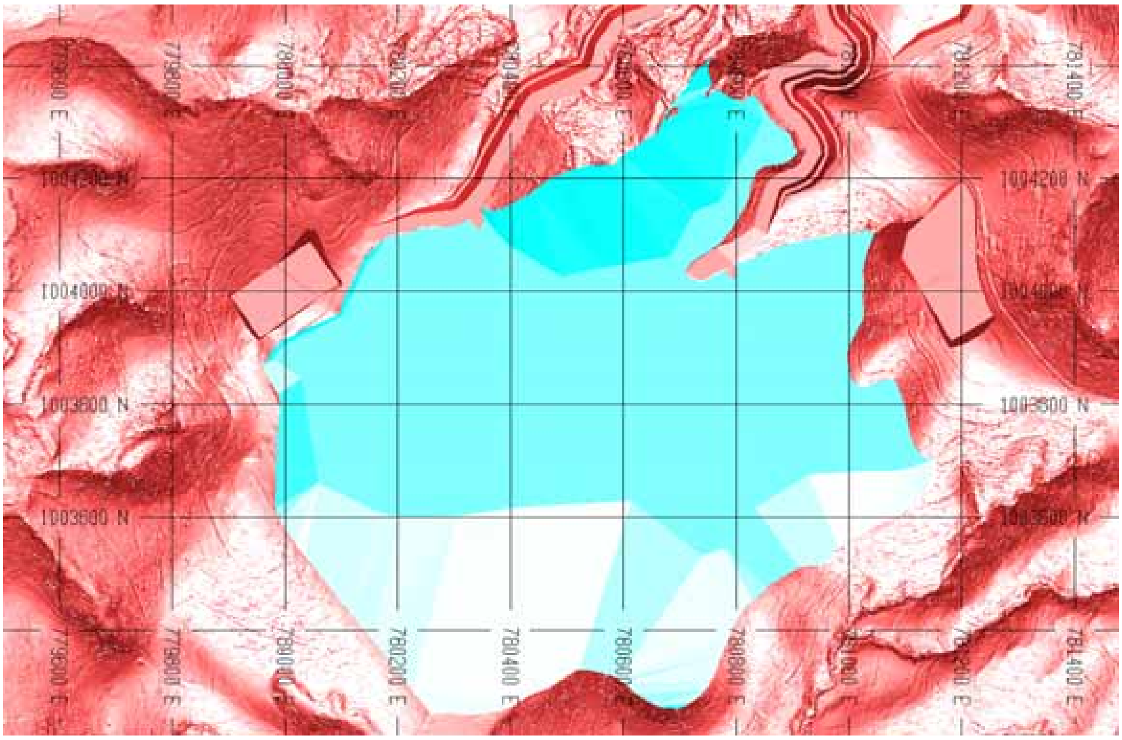
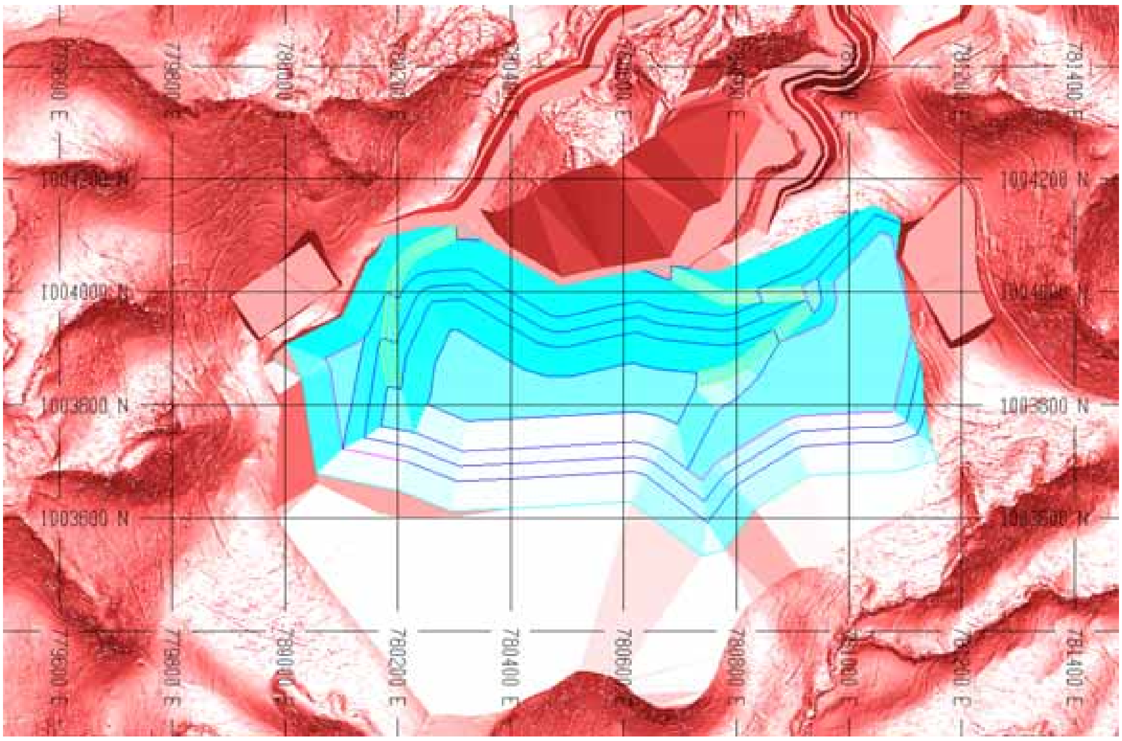


Figure 5.42 Southern dump top tier



For the western dump, a “bottom up” dumping strategy was again necessary and the western dump access road is shown in Figure 5.43. The western dump is shown in Figure 5.44.

Figure 5.43 Western dump bottom access road

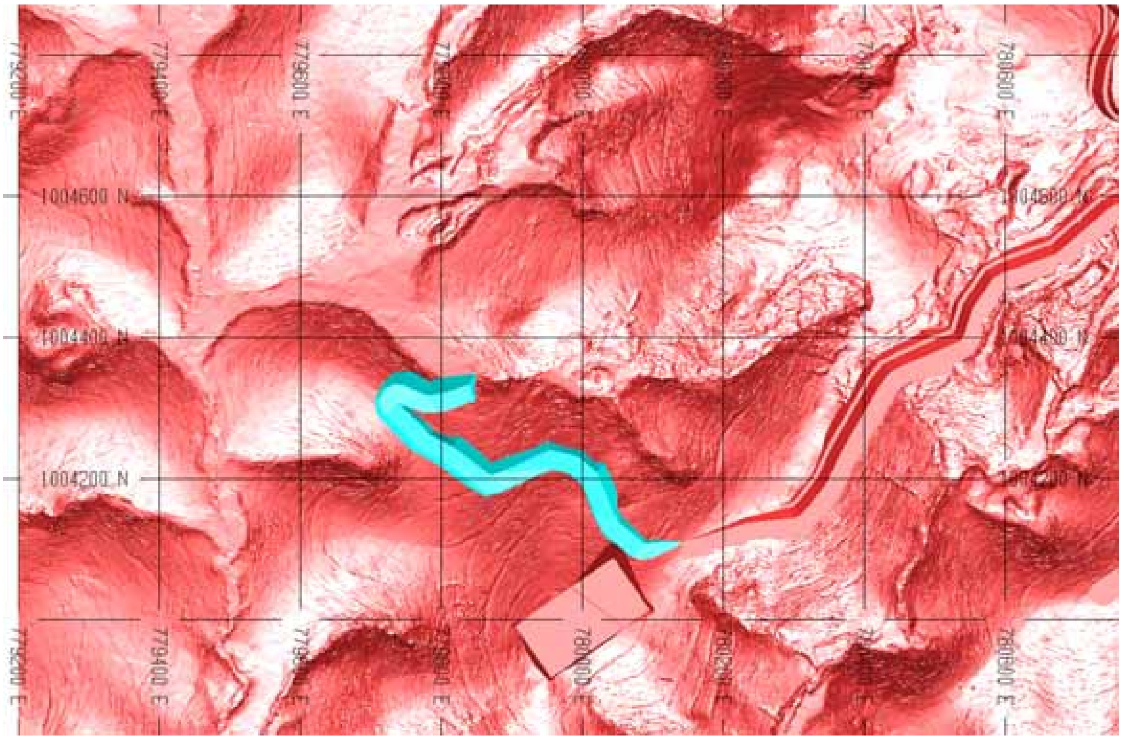


Figure 5.44 Western dump

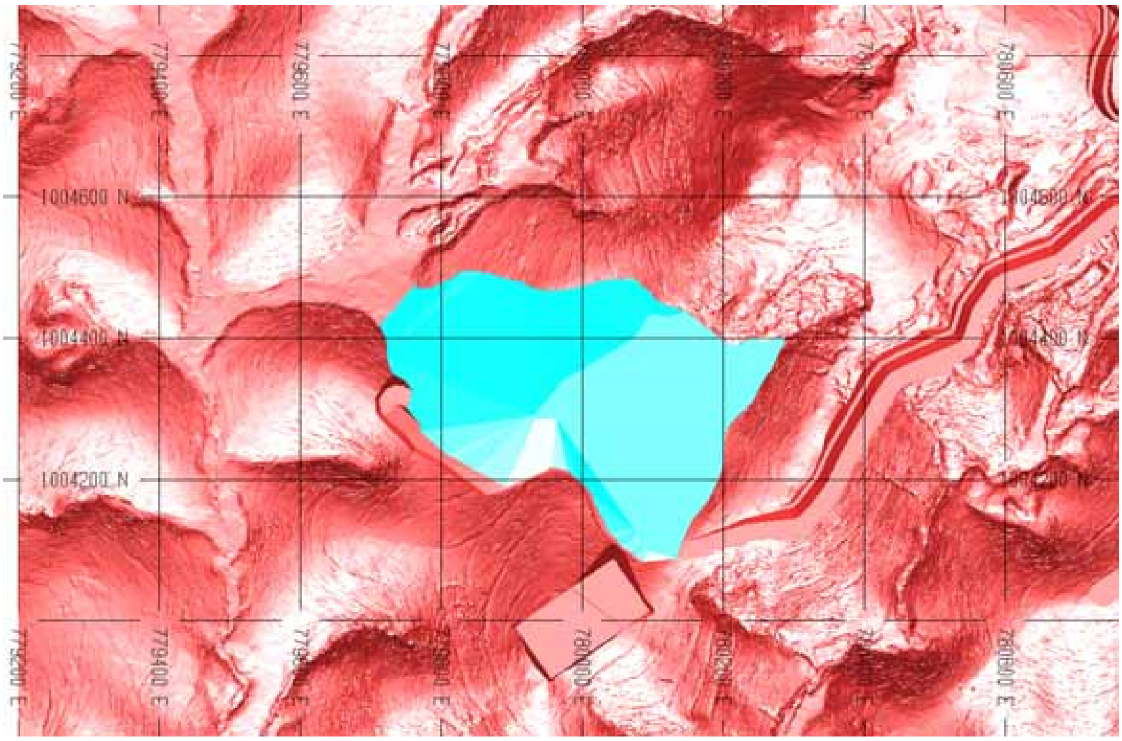


Table 5.17 shows the loose cubic metre ("LCM") values for each of the dump, stockpile and road designs. Snowden used a 25% swell factor.

Table 5.17 Dump volumes

	Unit	Value
ROM pad		
Stage 2	LCM	2.7 M
Stage 3	LCM	8.1 M
Skyway	LCM	0.2 M
Stockpiles		
High grade	LCM	0.84 M
Low grade	LCM	1.5 M
Access roads		
Pit Stage 4	LCM	0.1 M
Southern dump east	LCM	0.7 M
Southern dump west	LCM	0.6 M
Western dump	LCM	0.1 M
Dumps		
Pit Stage 4	LCM	0.6 M
Southern dump bottom tier	LCM	32.4 M
Southern dump top tier	LCM	11.3 M
Western dump	LCM	3.0 M

Asymmetric views of the ultimate Tulu Kapi pit, with the surrounding mining infrastructure at the completion of the stockpile reclaim, is provided in Figure 5.45 and Figure 5.46.

Figure 5.45 Final surface northeast asymmetric

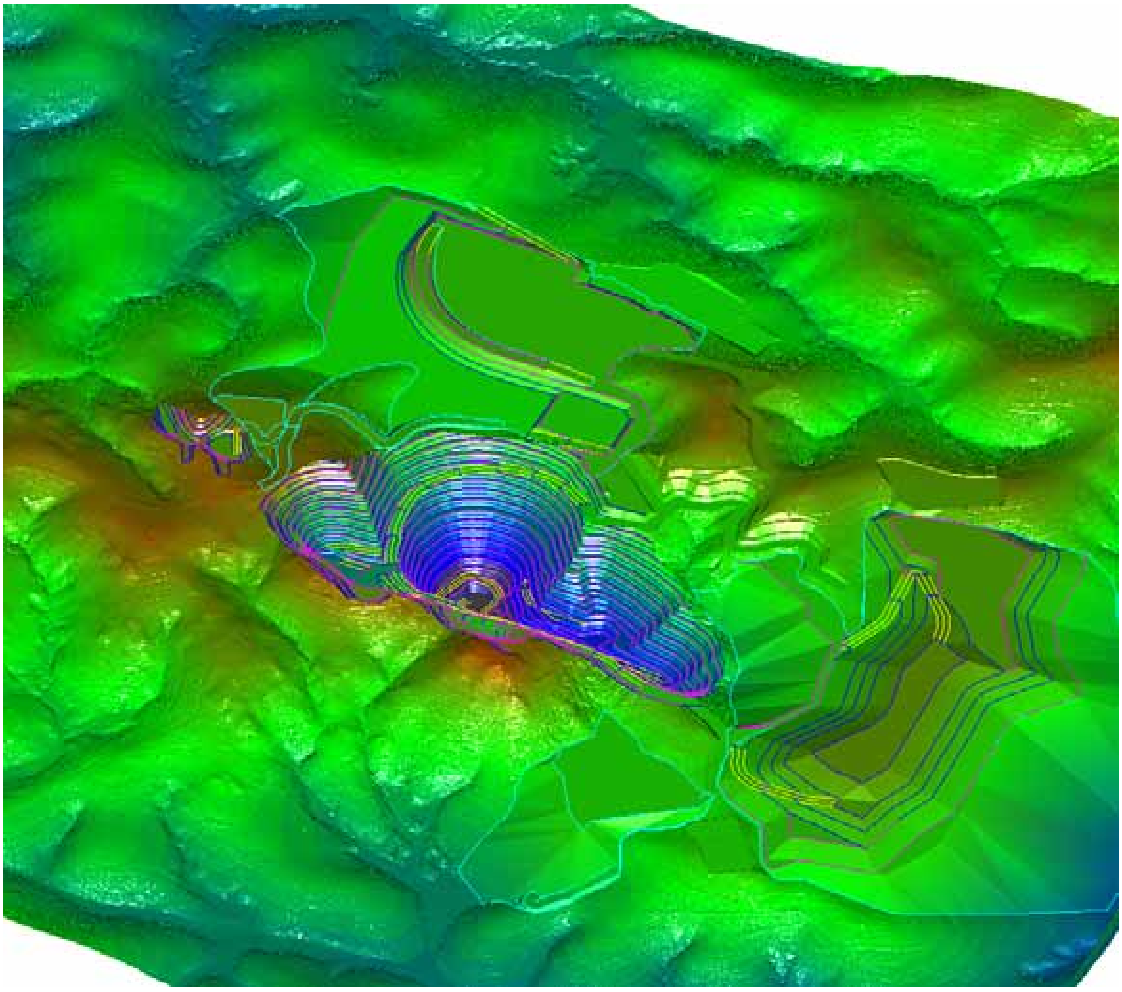
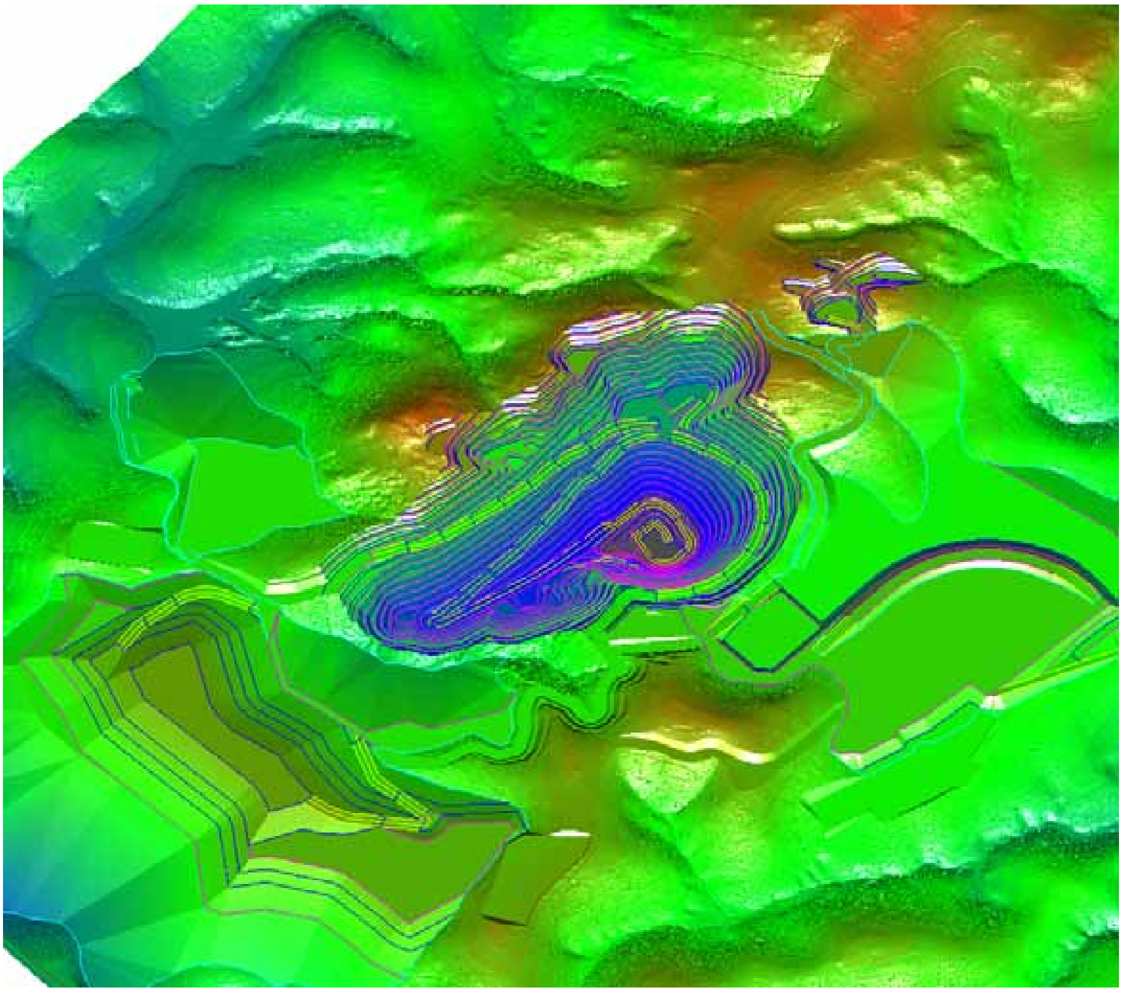


Figure 5.46 Final surface northwest symmetric



5.6 MINING SCHEDULE

Snowden utilised its proprietary software "Evaluator", a mixed integer linear program ("MILP") optimisation scheduler, to determine a mining schedule that maximises NPV while maintaining practical mining constraints.

Snowden scheduled the mining production and plant processing activities including a quarter of pre-processing mining, as a pre-strip period. Any movements attributed to the construction period were excluded. The construction period will use a different fleet to move material required for mining activities to commence. The pre-strip quarter was deemed necessary as there is insufficient ore in the first mining quarter to supply the mill. Stockpiling ore in the first quarter ensured feed to the mill would be adequate to maintain target throughput for the first year.

5.6.1 Schedule constraints

Table 5.18 summarises the parameters used in the Evaluator optimisation.

Table 5.18 Schedule parameters

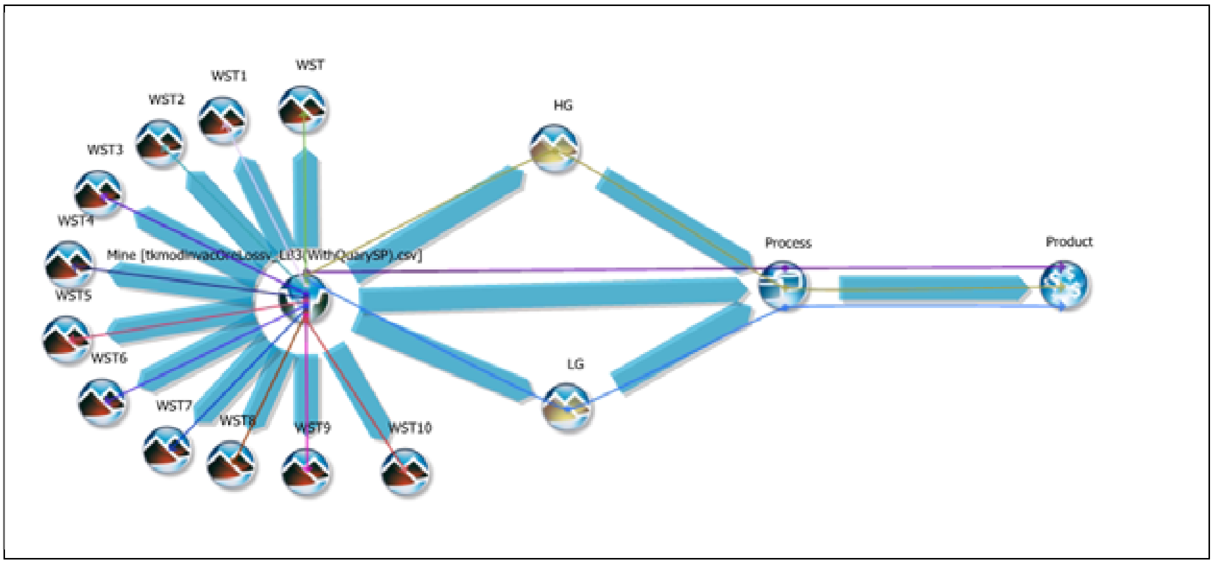
Parameter	Value
Constraints	
Maximum mining rate	18.5 Mtpa
Maximum processing rate	0.0 Mtpq (Q -1)
	0.2 Mtpq (Q1)
	1.2 Mtpa (>=Q2)
Vertical advance	45.0 mpa (six benches)
Production ramp-up	200 kt in Q1

There was no requirement for the fresh, hard or saprolite to be blended in any way for process feed. There was no minimum grade applied to the mill except that of the inventory cut-off grade at 0.5 g/t Au. For the first 10 years the high grade material above a cut-off grade of 0.9 g/t was used.

A high-grade ore stockpile was used to defer low-grade ore, thereby raising the ore grade in the early years of processing. There was no limit to the high-grade ore stockpile size.

The flow diagram in Figure 5.47 shows the pit as the mining rock source and the various destinations.

Figure 5.47 Evaluator flow network



5.6.1.1 Stage sequencing

A total of six stages were used in the production schedule with the consideration that Stage 3 (TL3) is subdivided into three stages. The schedule sequencing followed the practical design constraints that were attained by using temporary ramps when necessary as outlined in the design Section 0. The schedule allowed for three stages to be mined concurrently. However there were three quarters where four stages were mined concurrently. Snowden considered that this could be accomplished with only three excavator machines, implying small tonnages in one or two of the stages that could be chained in the quarter and mined in series, rather than concurrently.

5.6.2 Results

The results of the mine production schedule are shown in in the following tables. The mining schedule is summarised in Table 5.19, the stockpiling schedule is summarised in

Table 5.20 and the processing schedule summarised in Table 5.21 and the mining quarterly advance is presented graphically in Annexure A.

Table 5.19 Tulu Kapi mining schedule

Mining	Total	Period											
		-1	1	2	3	4	5	6	7	8	9	10	11
Pit Base (mRL) - TL1	1,760.0	1,745.0	1,700.0	1,655.0	1,610.0	1,565.0							
Pit Base (mRL) - TL2	1,752.5			1,722.5	1,692.5	1,647.5	1,610.0	1,572.5	1,527.5	1,505.0			
Pit Base (mRL) - TL3	1,730.0					1,707.5	1,662.5	1,617.5	1,572.5	1,527.5	1,482.5	1,452.5	
Pit Base (mRL) - TL4	1,745.0											1,707.5	1,707.5
Total movement (kt) - TL1	38,281.3	749.8	11,642.5	14,830.9	8,590.4	2,467.8							
Total movement (kt) - TL2	54,297.6			890.3	9,909.6	16,015.6	14,603.1	8,091.5	4,264.3	523.2			
Total movement (kt) - TL3	36,038.7					16.7	3,896.9	10,408.5	9,951.6	7,050.1	3,778.8	936.2	
Total movement (kt) - TL4	911.1											825.1	86.0
Total movement (kt)	129,528.7	749.8	11,642.5	15,721.2	18,500.0	18,500.0	18,500.0	18,500.0	14,215.9	7,573.2	3,778.8	1,761.3	86.0
Waste (kt)	114,199.6	646.6	9,849.0	13,026.6	16,430.9	17,347.0	16,590.3	17,092.9	12,316.3	6,262.5	3,143.2	1,434.6	59.7
Total ore (kt)	15,329.1	103.2	1,793.5	2,694.6	2,069.1	1,153.0	1,909.7	1,407.1	1,899.6	1,310.8	635.6	326.8	26.2
- Grade – Au (g/t)	2.12	1.29	1.44	2.20	2.05	2.06	2.10	2.11	2.12	2.46	3.33	2.78	1.43
Saprolite (kt)	882.8	95.2	495.3	144.6	64.4	0.2	1.0	13.5				66.3	2.3
- Grade – Au (g/t)	1.55	1.29	1.53	1.85	1.72	3.58	0.72	1.24				1.29	1.09
Fresh (kt)	10,080.8	8.0	1,298.1	2,550.0	2,004.7	980.4	1,908.7	793.0	424.5			89.4	24.0
- Grade – Au (g/t)	1.99	1.33	1.41	2.22	2.06	1.91	2.10	1.97	2.09			1.27	1.46
Hard (kt)	4,365.5					172.4		600.6	1,475.1	1,310.8	635.6	171.1	
- Grade – Au (g/t)	2.54					2.91		2.32	2.13	2.46	3.33	4.14	

Table 5.20 Tulu Kapi stockpiling schedule

Stockpile	Total	Period													
		-1	1	2	3	4	5	6	7	8	9	10	11	12	13
HG STOCKPILE															
Addition															
Total (kt)	3,055.9	64.5	225.1	1,024.4	631.4	185.2	350.5	149.6	332.2	85.9	7.0				
- Grade – Au (g/t)	1.23	1.64	1.00	1.44	1.22	1.04	1.12	1.01	1.11	0.98	0.95	2.34			
Reclaim															
Total (kt)	3,055.9	0.0	63.2	0.0	208.8	524.9	52.3	283.6	14.7	203.1	645.4	896.0	163.9		
- Grade – Au (g/t)	1.23		1.69		1.99	1.53	1.35	1.29	1.37	1.18	1.09	0.99	0.95		
Size															
Total (kt)		64.5	226.4	1,250.8	1,673.4	1,333.7	1,631.9	1,497.9	1,815.4	1,698.2	1,059.8	163.9			
- Grade – Au (g/t)			0.99	1.36	1.23	1.08	1.08	1.03	1.04	1.03	0.98	0.95			
LG STOCKPILE															
Addition															
Total (kt)	3,285.6	38.7	571.1	470.2	446.4	292.7	411.6	341.1	382.1	228.0	74.0	29.7			
- Grade – Au (g/t)	0.70	0.70	0.69	0.71	0.70	0.70	0.70	0.69	0.69	0.71	0.70	0.68			
Reclaim															
Total (kt)	3,285.6												1,009.7	1,200.0	1,075.9
- Grade – Au (g/t)	0.70												0.7	0.7	0.7
Size															
Saprolite (kt)		35.7	187.9	218.0	233.0	233.0	233.9	238.6	238.6	238.6	238.6	245.0	245.0	245.0	
- Grade – Au (g/t)			0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	
Fresh (kt)		3.0	421.9	862.0	1,293.4	1,559.2	1,969.9	2,174.8	2,279.9	2,279.9	2,279.9	2,279.9	1,270.3	70.3	
- Grade – Au (g/t)			0.69	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.69	0.67	
Hard (kt)						26.9	26.9	158.5	435.4	663.4	737.3	760.6	760.6	760.6	
- Grade – Au (g/t)						0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	
Total (kt)		38.7	609.8	1,080.0	1,526.4	1,819.2	2,230.7	2,571.8	2,953.9	3,181.9	3,255.8	3,285.6	2,275.9	1,075.9	
- Grade – Au (g/t)			0.69	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.70	0.69	0.70	

Table 5.21 Tulu Kapi processing schedule

Processing	Total	Period													
		-1	1	2	3	4	5	6	7	8	9	10	11	12	13
Saprolite (kt)	936.9		361.6	58.8	29.5	24.4	0.01	23.4			16.3	158.5	3.1	0.0	261.4
- Grade – Au (g/t)	1.56		2.08	2.93	2.70	1.59	1.33	1.40			1.15	1.13	1.05	0.75	0.70
Fresh (kt)	10,090.9		738.4	1,141.2	1,170.5	1,057.4	1,200.0	780.6	243.7	175.8	586.7	691.5	1,033.9	1,200.0	71.3
- Grade – Au (g/t)	1.99		1.92	3.46	2.98	2.17	2.83	2.16	3.01	1.16	1.08	1.00	0.73	0.69	0.67
Hard (kt)	4,365.5					118.3		396.0	956.3	1,024.2	597.0	350.1	163.1		760.6
- Grade – Au (g/t)	2.54					3.82		3.09	2.80	2.95	3.54	2.60	0.95		0.70
Total (kt)	15,393.4		1,100.0	1,200.0	1,200.0	1,200.0	1,200.0	1,200.0	1,200.0	1,200.0	1,200.0	1,200.0	1,200.0	1,200.0	1,093.4
- Grade – Au (g/t)	2.12		1.97	3.44	2.97	2.32	2.83	2.45	2.84	2.68	2.30	1.48	0.76	0.69	0.70
Metal															
Mined - Au (koz)	1,046.7	4.3	83.3	190.6	136.3	76.5	128.7	95.4	129.5	103.7	68.0	29.2	1.2		
Feed - Au (koz)	1,050.3		69.8	132.5	114.8	89.5	109.1	94.7	109.7	103.6	88.8	57.3	29.2	26.7	24.5
Recovered - Au (koz)	959.6		64.6	123.0	106.4	82.4	101.2	86.4	98.9	92.7	79.9	51.8	26.4	24.2	21.9

There were three quarters where four stages were mined concurrently. Snowden considered that this could be accomplished with only three excavator machines, implying small tonnages in one or two of the stages that could be chained in the quarter and mined in series, rather than concurrently.

The quarterly mining production schedule is provided by Snowden graphically and summarised as yearly output in Figure 5.48 to Figure 5.55. Snowden utilised a high grade stockpile (above 0.9 g/t of gold) and low grade stockpile (0.5 g/t to 0.9 g/t of gold) to produce a 13 year schedule. Mining ceases in Quarter 42 (LOM) and processing in Quarter 53. The schedule satisfies the mill and maintains an aggressive grade profile that diminishes with LOM, while complying with the set constraints. The smooth total movement profile ensures manageable fleet numbers. **Error! Reference source not found.** contains an expanded tabled result of the schedule.

Figure 5.48 Tonnes mined by stage

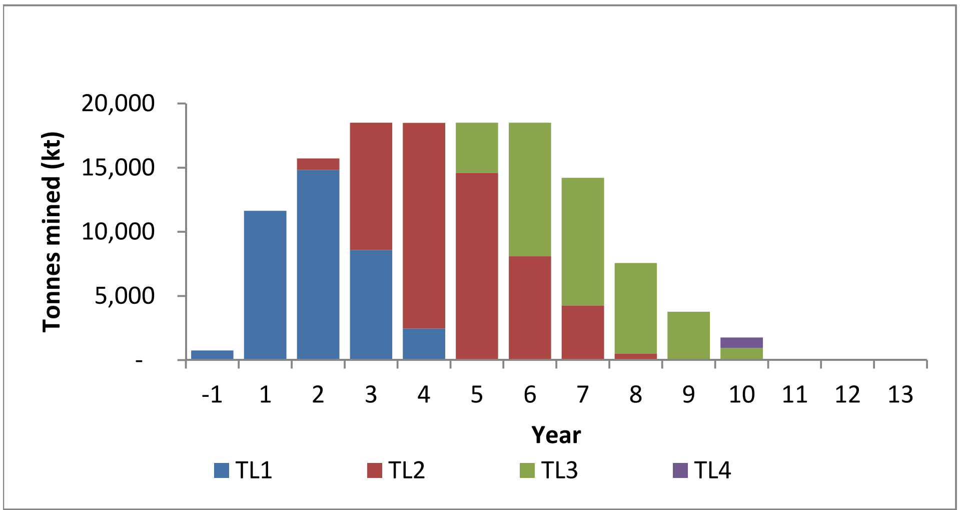


Figure 5.49 Ore mined by rock type

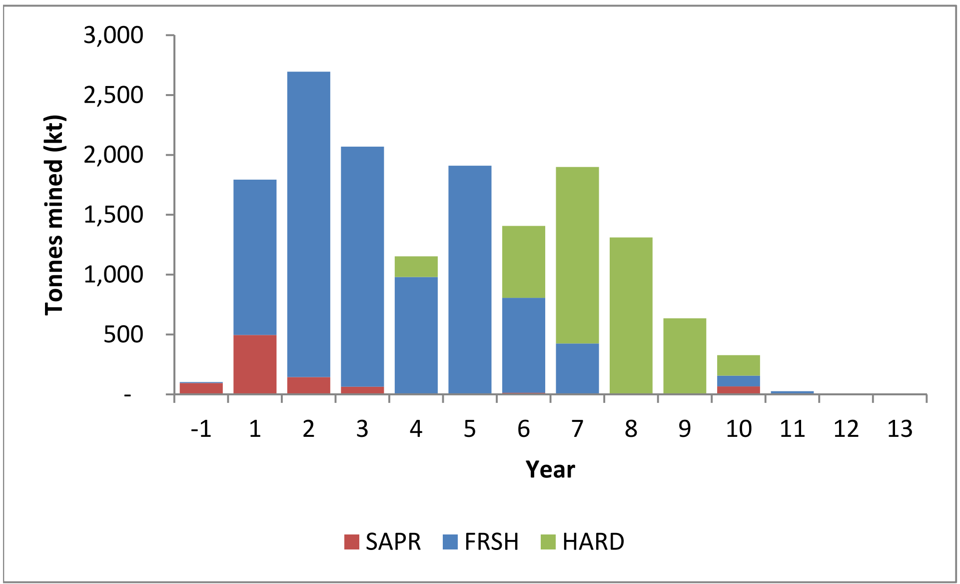
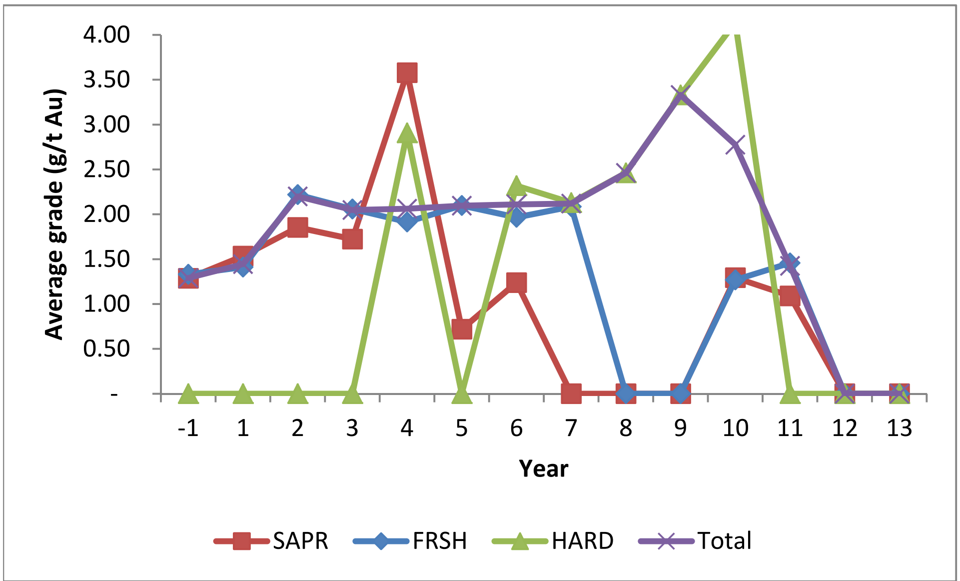


Figure 5.50 Au grade mined by type



Both high grade and low grade stockpiles were accumulated in the pre-strip period in Quarter -1.

Figure 5.51 High grade stockpile size

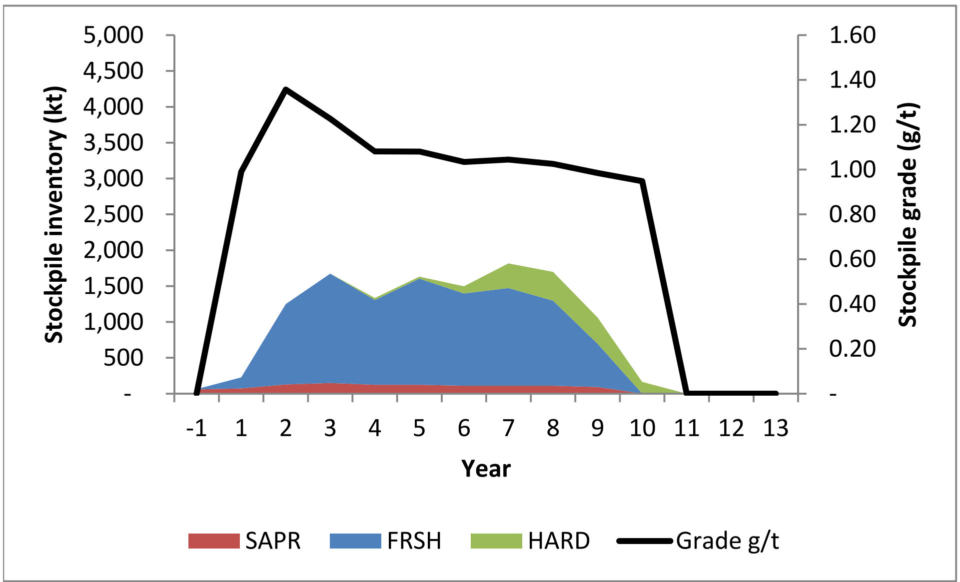
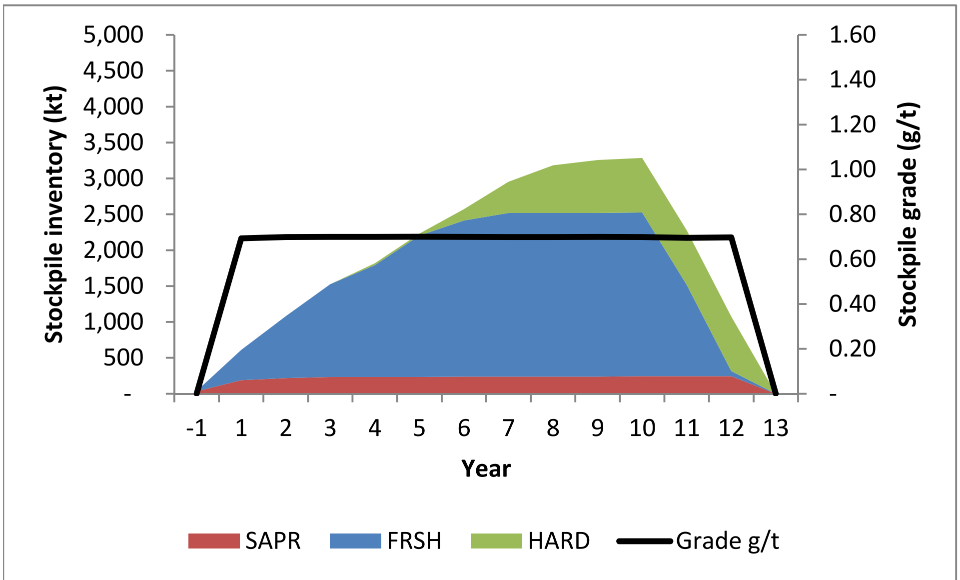


Figure 5.52 Low grade stockpile size



Saprolite was processed in Year 10 as this material is fed from the low grade stockpile and was dumped early in the mine life. Directional dumping was used on the low grade stockpile enabling the material to be reclaimed on a yearly basis. The higher grades of the low grade stockpile were processed as early as possible after Year 10.

Figure 5.53 Ore processed by type

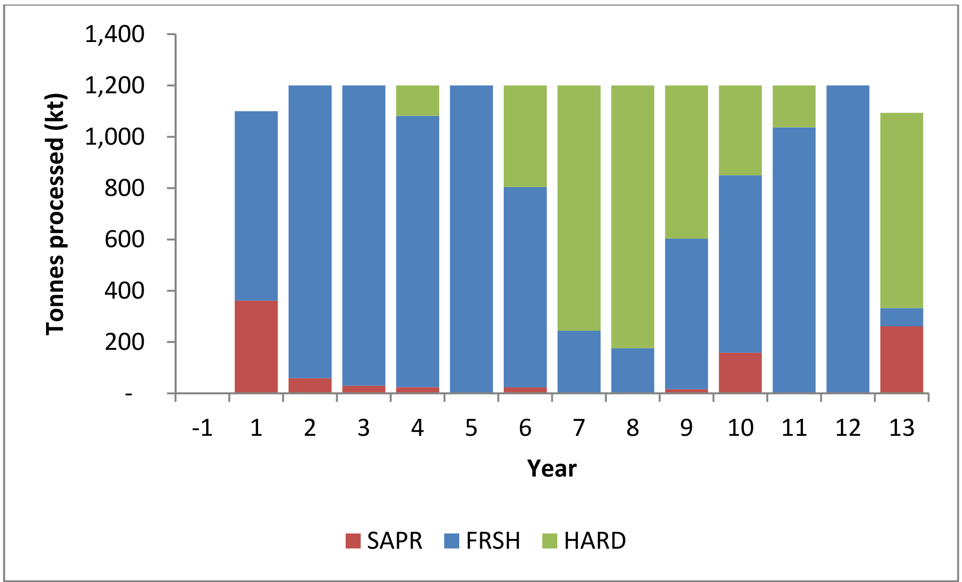
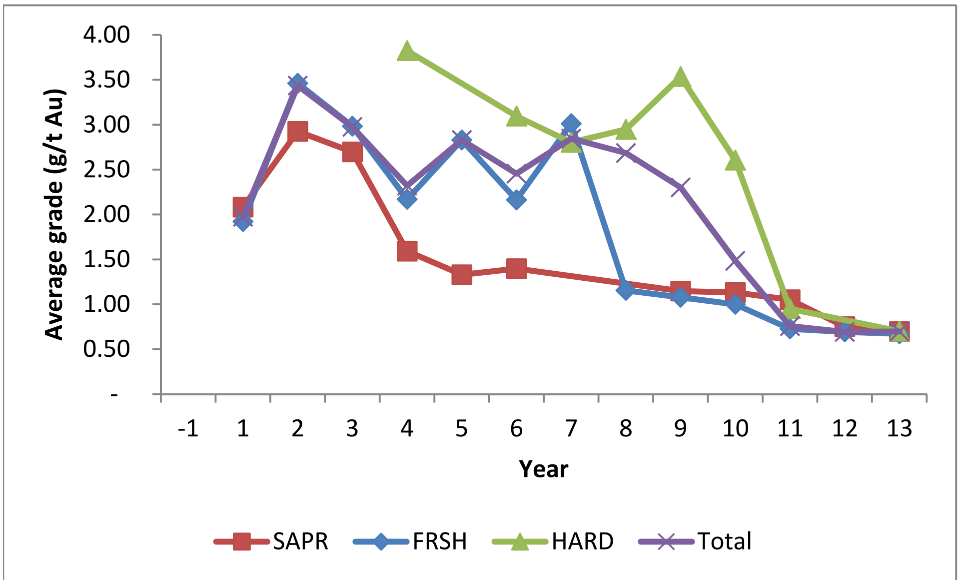
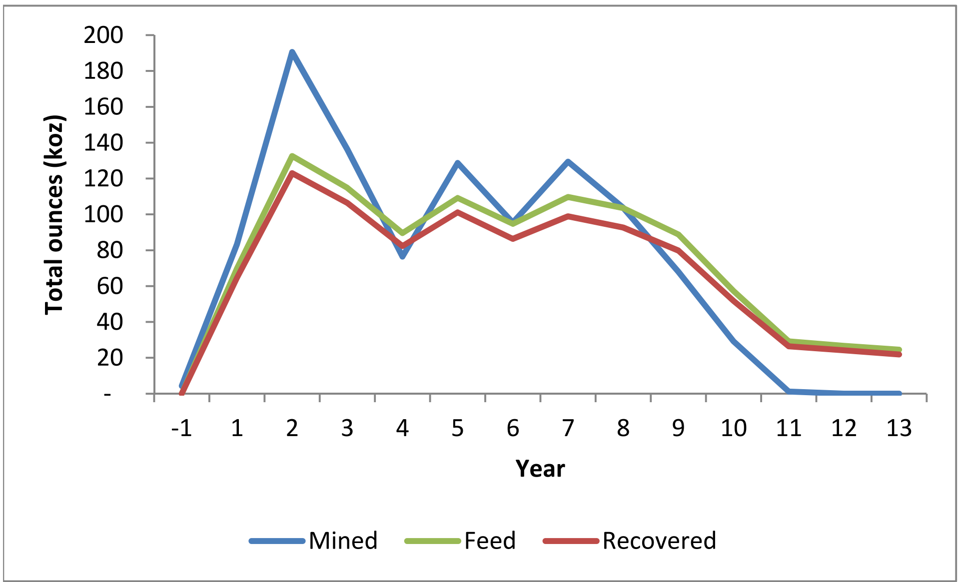


Figure 5.54 Au grade processed by type



Snowden initially provided the Stage 3 of the pit as a single stage, however by dividing the stage into three smaller stages Snowden was able to improve an ounce deficiency in Years 3 and 4 and an improved result was provided as shown in Figure 5.55.

Figure 5.55 Au ounces recovered summary



5.7 EQUIPMENT SELECTION

The equipment selected for the Tulu Kapi project and the basis for this selection is given below. Specific equipment are identified to provide context to the provisions made within the mining study. It should be noted that other vendor equipment are available which could potentially fulfil some of the requirements outlined below; however, commercial information of these machines was unavailable to enable them to be considered. A more detailed review of the make, model and specification of the machines is recommended prior securing agreements with vendors. It is however expected that the ultimate specification will not vary materially from the machines outlined below.

5.7.1 Excavator

Three sizes or excavator are proposed for Tulu Kapi, each of which will perform specific mine production duties as identified in Table 5.22.

Table 5.22 Excavator tasks by machine size

	Machine size		
	40 t to 50 t	120 t to 150 t	180 t to 200 t
Borrow pit earthworks		●	
Selective mining		●	
Bulk excavation			●
Batter pulling	●		
Rock breaking	●		

Topsoil rehandle	●

Both the 120 t and 200 t machines will be capable of loading the haul trucks. The 120 t class machine was included for its selective mining capability and flexibility during the construction phase. The 200 t machine is the largest machine capable of loading the proposed mine trucks. This will enable higher production rates and reduce the number of loading areas required, thereby providing more flexibility within the working areas of the pit.

The 120 t machine will be brought to site during the construction period to produce borrow material for the TSF, raw water diversion dam and ROM pad. The 200 t machines will be mobilised in the quarter prior to commissioning of the process plant.

The 120 t machines will perform the crucial duty of separating the ore and waste selective material at the hangingwall and footwall contact. This will prepare the area for the larger 200 t machines to operate more efficiently in removing the stockpiled selective material as well as the bulk material on the flitch. One 120 t machine and up to three 200 t machines were allowed for in this study and the number of machines matches the requirement to achieve simultaneous mine production from three independent locations in the pit.

A smaller 40 t machine will be predominantly used to clean the batters of loose material and provide backup for sorting of the selective material. The same size machine will be fitted with a rock breaker to reduce oversize in the pit and on the ROM pad as required. Ancillary duties such as roadworks and drain clearing are assigned to this machine and only one machine is required for the Tulu mine.

A summary of the key specifications of machines considered appropriate for these duties is given in Table 5.23. Specifications for these machines are provided in **Error! Reference source not found.**.

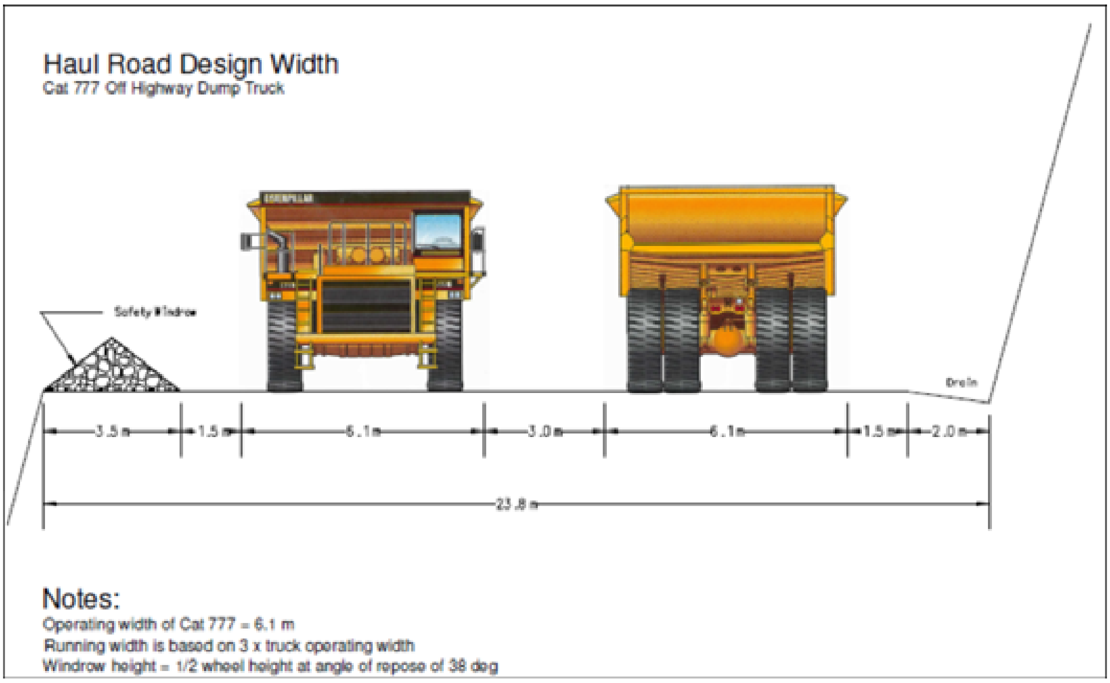
Table 5.23 Excavator key specifications

	Machine size		
	40 t to 50 t	**120 t to 150 t**	**180 t to 200 t**
Number	1	1	3
Make	Komatsu	Komatsu	Komatsu
Model	PC450	PC1250	PC2000
Bucket (m^3)	1.8	4.0	9.5
Capital ($M)	0.33	1.08	2.34
Make	Caterpillar	Caterpillar	Caterpillar
Model	349D2L	6015	6018
Bucket (m^3)	2.1	6.0	8.5
Capital ($M)	0.47	1.48	2.87

5.7.2 Mine dump trucks

Rigid body 90 t class mine dump trucks are proposed for the project. This size machine maximises the use of the design width of the pit ramps and surface haul roads (25 m). The trucks will be typically 6 m wide and require a minimum running surface of 18 m for dual lane ramps and 9 m for single lane ramps. The remainder of the design width will allow for toe drains and safety windrows. The Cat 777 (90 t class) truck model is shown in Figure 5.56, with the Caterpillar ramp design constraint.

Figure 5.56 Caterpillar 777 truck and ramp design constraint (Caterpillar Inc.)



This size of truck was selected to also maximise the size of excavator which can be used in the pit for digging bulk ore and waste as well as re-handling the selective material stockpiled by the 120 t machine described earlier. This will minimise the number of loading areas required to maintain the proposed production rate.

Productivity estimates were based on the use of the Komatsu HD785. This was largely due to the higher performance characteristics compared to its Caterpillar counterpart, the Cat 777D.

A summary of the key specifications for the machine are given in Table 5.24. Specifications for these machines are provided in **Error! Reference source not found.**.

Table 5.24 Mine dump truck key specifications

Make	Komatsu	Caterpillar
Model	HD785-7	777D
Number	13	14
Nominal Payload (wmt)	91.0	90.4
GVW	166	163
Rated Power	879	699
Power:Weight	5.30	4.29
Capital ($M)	1.27	1.33

5.7.3 Dozer

Two dozer configurations were selected for the project. It was estimated that two track dozers and one wheel dozer will be required.

5.7.3.1 Track dozers

Track dozers will be required to carry out the following tasks:

- Clear and grub
- Topsoil removal
- Construction of temporary in-pit ramps
- Pit floor maintenance
- Waste dump and skyway maintenance
- Environmental duties of:
- Waste dump battering for rehabilitation
- Topsoil spreading
- Ripping and seeding.

The dozers proposed would be circa 400 kW/70 t class machines and are typical for this scale of operation. It was estimated that two machines will be required at the peak of operations.

5.7.3.2 Wheel dozer

A wheel dozer was included in the ancillary mining fleet. Its primary functions will include the following:

- Clean up of spillage around the loading and dumping area
- Clean up of spillage on ramps
- Maintaining pit floors
- Preparation of blasting areas for drilling.

The key reason for including a wheel dozer in the mining fleet is its ability to move quickly between loading areas (and dumping areas) for clean-up, thereby reducing the risk of tyre damage and subsequent truck downtime.

The proposed wheel dozer will be a circa 400 kW/45 t machine. A summary of the key specifications for the machine are given in Table 5.25. Specifications for these machines are provided in **Error! Reference source not found.**.

Table 5.25 Dozer key specifications

Make	Komatsu	Caterpillar	Komatsu	Caterpillar
Model	D375A-5	D10T2	WD600-3A	834K
Configuration	Track	Track	Wheel	Wheel
Number	2	2	1	1
GVW	71.64	66.451	42.9	47.75
Rated Power	391	433	363	370
Power:Weight	5.46	6.52	8.46	7.75
Capital ($M)	0.80	1.63	0.60	1.25

5.7.4 Front-end loader

No provision was made in the primary mining fleet for a front-end loader. The ROM loader to feed the crusher is covered under processing costs prepared by SENET. The production schedule has 41% of ore is rehandled from the stockpiles and 59% is direct tipped to the crusher.

5.7.5 Drills

5.7.5.1 Blasthole drills

The main production blasthole size proposed will be 114 mm diameter. The blastholes will be drilled on 7.5 m bench with 0.75 m of sub-drill plus an allowance of 0.3 m for material fall back. This gives a total depth drilled of 8.3 m.

The proposed hole size can be efficiently drilled by both top-hole-hammer ("THH") drills and down-the-hole-hammer ("DTH") drills. It is however expected that the THH drills will be more productive with estimated penetration rates of circa 20 m/hr to 25 m/hr compared to DTH drills, which are estimated to be typically 5 m/hr slower for the same conditions.

The selection of blasthole drill was based on the following considerations:

- **Hole depth**: To minimise the time lost in rod changing, a long mast drill was proposed
- **Rock compressive strength**: The rock compressive strength is understood to be in the range of 140 Mpa to 200 Mpa. To maximise the productivity, a high powered rock drill was selected
- **Flexibility in hole size**: To provide flexibility, the drill selected would be ideally capable of drilling a 89 mm to 102 mm diameter and single pass drill a hole to a depth of 5.5 m without a rod change.

The drills identified as capable for the expected duties are summarised in Table 5.26.

5.7.5.2 Grade control drills

Reverse circulation ("RC") methods will be used as part of the grade control strategy. Holes drilled for RC sampling will be incorporated into the blast pattern and therefore drilled vertically at a diameter of 114 mm, the same at the blastholes. Final hole depth will be 8.5 m.

The RC drill will also be capable of drilling alternative grade control patterns such as inclined holes to a depth which covers three to four benches.

To provide flexibility for RC grade control drilling, a boom mounted DTH long mast drill was selected for the project. The drills provide flexibility and can be modified to conventional DTH which will increase their productivity.

The RC drills will be fitted with a conventional sample collection system including a cone splitter. The on-board compressor will be of specification that maximises the productivity of the hammer and sample collection system.

The drill identified at meeting this criteria is given in Table 5.26.

Table 5.26 Drill rig key specifications

Make	Blasthole drill		RC drill
	Atlas Copco	Caterpillar	Atlas Copco
Model	T45	M5150	D65
Number	2	2	4
Rock drill (kW)	25	32	995 cfm at 435psi
Hole sizes (mm)	89 to 140	89 to 152	110 to 203
Lead rod	6.10	6.10	7.50
Carousel rod	4.20	4.30	6.00
Capital ($M)	0.87	0.98	1.59

5.7.6 Grader

Provision was made for up to two graders to be included in the fleet. The proposed graders will have a 4.9 m (16 ft) mould board and will be used for haul road maintenance around the site.

The size of grader proposed is commonly used in combination with the proposed trucking fleet and was selected to minimise the number of passes required to maintain each section of road and therefore interference with the haulage fleet.

5.7.7 Water cart and standpipe

Provision was made for up to two water carts to be included in the fleet. The water carts will have a storage capacity of 30,000 litres and will be used primarily for dust suppression on haul roads and in the bench working areas. They will also assist in the ore sorting process carried out in the pit by the excavator, by cleaning faces if necessary.

The water cart will be fitted with a spray cannon to direct water onto the blasted muck pile to maximise the visibility of ore and enable the excavator to more efficiently separate ore from waste.

The water cart will be complemented by a high capacity standpipe pump which will be located at the Raw Water Diversion Dam. The standpipe will be diesel powered and capable of pumping rates of up to 220 litres/second ("l/sec"), enabling the water carts to be filled in under five minutes.

5.7.8 Fuel and lube truck

Provision was made for one fuel and lube truck to be included in the fleet. The truck will have a diesel storage capacity of 9,000 litres and will carry storage tanks for key lubricants such as hydraulic, engine and transmission oils as well as grease.

The fuel truck will primarily provide support to the track mounted equipment in the field that cannot readily return to the fuel bay and workshop area. This equipment will include:

- Excavators
- Blasthole drills
- RC drills
- Track dozers.

It is expected that the primary fleet will require refuelling on a daily basis with the ancillary fleet requiring refuelling on alternate days, depending on usage.

5.7.9 Crusher and screens

Roadbase and stemming aggregate will be required for the project on an ongoing basis. The peak roadbase requirement of 5,000 tonnes per month ("tpm") is estimated for roads and laydown areas.
The material size distributions for each of these products was not considered to be compatible with the screen sizes available in the process plant; therefore a small independent crushing and screening unit was included in the mining study.
The crusher will be capable of 40 tonnes per hour ("tph") and will produce up to three sizes of material, depending on requirements. The crusher will be loaded by the integrated tool ("IT") carrier using a 3 m^3 bucket.

5.7.10 Provision for service equipment

A range of service support equipment has been included and is described in brief below:

5.7.10.1 Batter excavator

A circa 50 t class excavator was included for batter cleaning and scaling to minimise fall rock into the working area.

5.7.10.2 Rock breaker

A circa 50 t class excavator was allowed for which will be equipped with a 4 t hydraulic breaker for reducing oversize rock in the pit and in the ROM pad area.

5.7.10.3 Stemming truck

A 15 m^3 stemming truck was included to allow crushed aggregate to be loaded directly into the hole. The truck is fitted with scalping screens above the storage body to prevent oversize entering the system. A transverse conveyor is used to discharge stemming into the hole.
The truck was included to avoid the need for manually stemming holes which is a slower process and carries a higher risk of damaging the downlines.

5.7.10.4 Lighting towers

Provision was made for up to six lighting towers. The lighting towers will have a coverage area of 3,800 m^2 and will be located in working areas of the pit and active dumping areas.
It was assumed fixed lighting will be provided at the ROM pad.

5.7.10.5 Integrated tool carrier

An IT carrier was included, complete with forks and bucket. This machine will be used for general duties around the workshop area and in the pit where it will be used for relocating pumps and other equipment required from time to time.

5.7.10.6 Minor equipment

Other minor equipment included in the study are as follows:

- One backhoe for cleaning drains and digging trenches
- One skidsteer loader for general clean up in confined areas
- One 25 t mobile crane for removing machine components during servicing and rebuilds
- Three dewatering pumps each capable of 150 l/sec at 110 m total head.

5.7.11 Light vehicles

Four-wheel drive light vehicles were included in the mining study for management supervisory roles and maintenance support. The allocation of four-wheel drive vehicles is given in Table 5.27.

Table 5.27 Four-wheel drive light vehicle provisions

	Single cab utes	Twin cab utes	Land Cruiser wagon	Total
Mining Management				
Mine Manager	-	-	1	1
Mine Technical Service Department				
Technical Services Superintendent	-	-	1	1
Mining Engineer – Production	-	1	-	1
Chief Geologist	-	-	1	1
Mine Geologist	-	1	-	1
Senior Mine Surveyor	-	1	-	1
Mine Operations				
Mine Operations Superintendent	-	-	1	1
Mining General Supervisor	-	1	-	1
Production Supervisors – Shift	1	-	-	1
Drill and Blast Supervisor	1	-	-	1
Blast Crew – Day Shift	2	-	-	2
Mine Maintenance				
Mine Maintenance Superintendent	-	-	1	1
Mine Maintenance Supervisor	-	1	-	1
Maintenance Leading Hands – Shift	1	-	-	1
Fitters – Shift	2	-	-	2
Tool Storekeeper	1	-	-	1
Total	**8**	**5**	**5**	**18**

Provision was also made for up to four 22-seater coaster-style buses to transport work crews to and from the pit at shift change and meal breaks.

A nominal allowance was also included for two second-hand flatbed trucks to transport longer or larger equipment and components around the site.

5.8 OPERATING COSTS

Operating costs were developed on an owner-operator basis using original equipment manufacturer ("OEM") data and defined as all day-to-day running expenses incurred by the operation after the commissioning of the process plant.

In general, the operating costs included the following activities:

- Drill and blast
- Load and haul (including selective mining)
- RC grade control drilling
- Road and dump maintenance
- Rehabilitation of dumps.

The operating cost estimate was compiled on a bottom up basis. Four key cost centres were considered:

- Plant
- Labour
- Materials
- Contract services.

Each of these cost centres are discussed in detail in the following section.

The mine operating cost was estimated to be $2.56/t based on a total material movement of 134 Mt.

5.8.1 Plant

5.8.1.1 Plant operating cost

Mine operating costs were built up (in part) using estimates of hourly operating costs of the mining fleet. The build-up for mobile fleet hourly operating cost is provided in detail in **Error! Reference source not found.** and given in summary in Table 5.28. The plant operating costs included provisions for the following:

- **Insurance**: Estimated on the basis of 1% per annum of the replacement cost of the machine. Equipment hours were assumed to average 5,000 hours per year.
- **Parts and rebuilds**: Includes major components replacement (e.g. engines, transmissions etc.) as well as minor components required for servicing the machine (e.g. filters and seals). Provision was also made for the cost of off-site labour associated with component rebuilds.
- **Fuel**: Diesel fuel was included at $0.84 per litre and was quoted by local vendors as a price delivered to site (**Error! Reference source not found.**). Fuel consumption was estimated on the basis of rated engine power and a consumption rate of 0.24 l/kWh and adjusted for an appropriate engine duty cycle (load factor). The mining operations will consume on average around 0.72 million litres per month, peaking at around 1.1 million litres per month.
- **Oil and lube**: OEM recommended change-out intervals were applied to rates quoted by local vendors (**Error! Reference source not found.**) for typical hydraulic, engine and transmission oil. Nominal provisions were made for grease.

- **Tyres**: Estimated tyre lives were varied depending on the machine. The major consumer of tyres will be the mining dump truck fleet. An average tyre life of 4,000 hours was applied to dump trucks and at the peak of operations it was estimated that up to 12 tyres per month will be required. Local vendors were unable to provide pricing for tyres at the time of this study. Tyre costs were taken from budget quotations provided by Australian vendors these were considered a reasonable representation of cost.
- **Ground engaging tools ("GET")**: Bucket teeth, adapters and cutting edges were included in the equipment operating cost estimate. A nominal provision was made, on a cost per hour basis, for wear of ground engaging tools in fresh rock. GET costs and lives were provided by Australian vendors (**Error! Reference source not found.**).
- **Dump bodies**: A nominal provision was made for dump body repairs required due to wear from tipping rock.
- **Damage provision**: A nominal 5% to 10% damage provision was included depending on the machine and its application. This is to cover for premature failure of components due inappropriate use or collisions that may occur in the normal course of the work.
- **Miscellaneous cost provision**: A nominal allowance of 5% was applied as contingency to cover for items not identified that are required for the maintenance and reliability of the machine.

Table 5.28 Mobile plant operating cost – mining

	Insurance ($/hr)	Parts and rebuilds ($/hr)	Fuel ($/hr)	Oil and lube ($/hr)	Tyres ($/hr)	GET ($/hr)	Dump bodies ($/hr)	Damage provision ($/hr)	Misc. cost provision ($/hr)	Total ($/hr)
Primary fleet										
Digger hours 180 t	4.67	123.85	122.18	8.81	-	23.18	-	13.90	13.90	310.50
Digger hours 150 t	2.15	104.53	86.02	5.43	-	16.33	-	10.62	10.62	235.70
Truck hours 90 t	2.54	47.94	70.88	4.98	15.02	-	5.00	14.38	7.19	167.92
Blasthole drilling	1.74	96.53	41.47	10.32	-	-	-	14.83	7.42	172.31
RC drilling	3.19	92.09	68.89	7.46	-	-	-	16.84	8.42	196.90
Ancillary fleet										
Track dozer	1.61	48.39	51.24	2.34	-	6.00	-	5.40	5.40	120.38
Wheel dozer	1.19	47.49	39.61	3.11	8.55	25.00	-	12.38	6.19	143.52
Grader	0.99	30.17	21.07	1.92	3.89	1.50	-	2.93	2.93	65.38
Water cart	1.44	22.72	37.40	1.94	10.38	-	-	1.45	3.62	78.94
Batter digger	0.67	52.72	44.04	2.34	-	10.00	-	10.91	5.45	126.13
Rock breaker	2.15	104.53	86.02	5.43	-	16.33	-	10.62	10.62	235.70
Stemming truck	0.99	15.91	39.31	0.79	7.41	-	5.00	6.84	3.42	79.67
Lighting towers	0.10	2.98	1.56	0.24	0.10	-	-	0.24	0.24	5.46
Fuel and lube truck	1.95	22.04	37.40	1.94	7.08	-	-	1.37	3.42	75.19
Minor equipment										
IT carrier with forks	0.83	31.13	18.61	1.14	2.48	-	-	1.07	2.67	57.93
Tyre handler	1.00	31.13	18.61	1.14	2.48	-	-	1.07	2.67	58.10
Backhoe	0.28	16.13	9.70	0.68	1.67	5.00	-	0.66	1.66	35.78

	Insurance ($/hr)	Parts and rebuilds ($/hr)	Fuel ($/hr)	Oil and lube ($/hr)	Tyres ($/hr)	GET ($/hr)	Dump bodies ($/hr)	Damage provision ($/hr)	Misc. cost provision ($/hr)	Total ($/hr)
Skidsteer loader	0.18	16.13	5.10	0.46	-	2.00	-	0.47	1.18	25.52
Standpipe	0.18	5.45	7.71	0.34	0.10	-	-	0.68	0.68	15.14
Mobile workshop crane 25 t	0.66	27.49	20.66	1.65	5.00	-	-	5.48	2.74	63.68
Dewatering pumps	0.53	11.13	64.51	0.97	0.36	-	-	1.54	3.85	82.89

	Insurance ($/hr)	Parts and rebuilds ($/hr)	Fuel ($/hr)	Oil and lube ($/hr)	Tyres ($/hr)	GET ($/hr)	Dump bodies ($/hr)	Damage provision ($/hr)	Misc. cost provision ($/hr)	Total ($/hr)
Light vehicles										
Single cab utes	0.08	11.13	18.35	0.55	1.67	-	-	3.17	1.58	36.53
Twin cab utes	0.08	6.13	18.35	0.55	1.00	-	-	1.30	1.30	28.71
Land Cruiser wagons	0.14	6.13	39.51	0.55	1.00	-	-	2.36	2.36	52.06
Coaster bus	0.15	6.13	15.52	0.55	1.80	-	-	1.20	1.20	26.55

5.8.1.2 Equipment productivity

Equipment productivities were applied to the mining schedule described in Section 5.6 to determine operating hours from which the equipment operating costs were estimated. The productivity calculations are provided in detail in **Error! Reference source not found.** with a summary discussion provided below. A summary of the machine hours allowed for in the project are given in Table 5.34.

A global operator efficiency factor of a 50 minute worktime per operating hour was applied to all productivity estimates.

5.8.1.2.1 Excavators

The 200 t class excavator productivity was estimated on an expected average loading cycle for a 90 t class dump truck. Loose densities assumed a 10% swell in saprolite and 30% swell in fresh material with an additional 5% was included for moisture content. Bucket fill factors of 100% for saprolite and 90% for fresh rock were applied to bucket sizes of 8 m^3 and 9.5 m^3 respectively. The production rates are given in Table 5.29.

The 120 t class excavator will be used to remove and stockpile the selective material at the ore/waste contacts. The productivity was estimate on the basis of a 50% bucket fill factor and 60 seconds per pass. Allowance was also made for repositioning the excavator as it moves along the contact during the selective mining. The production rates used are given in Table 5.29.

Table 5.29 Excavator productivities

Material	Units	200 t	120 t
Waste – Bulk			
Saprolite	tph	1,394	
Fresh	tph	1,431	
Hard	tph	1,347	
Waste – Selective			
Saprolite	tph		371
Fresh	tph		343
Hard	tph		343
Ore – Bulk			
Saprolite	tph	1,394	
Fresh	tph	1,431	
Hard	tph	1,347	
Ore – Selective			
Saprolite	tph		371
Fresh	tph		343
Hard	tph		343

5.8.1.2.2 Mine dump trucks

Mine dump truck productivity was estimated using a combination of travel time estimates and loading and dumping time estimates. Travel times were calculated using period haulage strings generated off quarterly mining face advances. Truck speeds were then applied depending on ramp or road profile, corner angle and whether the truck was loaded. All speeds where capped according to speed limits in Table 5.30. These numbers were then summed up along with allowances for congestion at intersections to provide haulage travel times.

Table 5.30 Travel time speed restrictions

Segment type	Loaded (km/hr)	Unloaded (km/hr)	Rolling resistance (%)
Flat	45	45	4
Ramp	30	30	4

The loading times were taken from the excavator productivity estimates. Dumping times allowed for 1 minute dumping at the waste dump and 1.5 minutes dumping time at the ROM pad to negotiate tipping from the skyway.

The average truck cycle times over the life of the project are given in Figure 5.57. The cycle times are relatively constant until around Year 8 where the haul distances increase as a result of increase in pit depth. The decrease beyond Year 9 is associated with the short hauls in Stage 4 and low grade stockpile reclaim.

Figure 5.57 Average cycle times for dump trucks

The truck fuel burn was calculated utilising the haulage strings created for the travel times. Fuel burn was applied to the strings using the selected truck's horsepower, energy efficiency factors and weight. The average fuel burn per hour was then estimated and applied in the hourly operating costs estimate shown in Table 5.28.

5.8.1.2.3 Drills

Drill productivities were derived from vendor estimates of instantaneous penetration rates with provision for other activities in the hole drilling cycle.

- Collaring
- Over-drill to allow for fall back
- Rod changing
- Movement between holes
- Sample clearing (RC only).

The estimated penetration rates are considered reasonable based on experience and are consistent with anecdotal estimates provided by contractors who have knowledge of the project.

The productivity estimates are given in Table 5.31.

Table 5.31 Drill penetration rates

Material	Units	Production drill	RC drill
Construction			
Saprolite	m/hr	49	41
Waste – Bulk			
Saprolite	m/hr	49	41
Fresh	m/hr	25	22
Hard	m/hr	20	16
Waste – Selective			
Saprolite	m/hr	49	41
Fresh	m/hr	25	22
Hard	m/hr	20	16
Ore – Bulk			
Saprolite	m/hr	49	41
Fresh	m/hr	25	22
Hard	m/hr	20	16
Ore – Selective			
Saprolite	m/hr	49	41
Fresh	m/hr	25	22
Hard	m/hr	20	16

5.8.1.2.4 Ancillary equipment

Ancillary equipment requirements were estimated by applying commonly used factors against the excavator fleet hours. The equipment and associated factors are given in Table 5.32.

Table 5.32 Ancillary fleet estimation factors

	Excavator size	
	200 t	120 t
Track dozer	0.4	0.4
Wheel dozer	0.2	0.2
Grader	0.4	0.4
Water cart	0.4	0.6
Batter digger	0.1	0.1

The fuel and lube truck was based on a nominal 5% of operating hours for the excavators and 2.5% of operating hours for other track mounted equipment.

5.8.1.2.5 Other

A variety of other productivities rates were applied for ancillary and miscellaneous tasks. These are summarised in Table 5.33.

Table 5.33 Miscellaneous productivity factors

Description	Units	Rate
Excavator stockpile rehandle to crusher	t/hr	1,007
Battering of waste dump slopes	m^3/hr	436
Topsoil spreading	hr/hectare	10.3
Ripping and seeding	hr/hectare	3.7
IT carrier with forks	hr/month	100
Tyre handler	hr/month	200
Backhoe	hr/month	20
Skidsteer loader	hr/month	20
Standpipe	hr/month	200
Mobile workshop crane 25 t	hr/month	50
Single cab utes	hr/month	100
Twin cab utes	hr/month	50
Land Cruiser wagons	hr/month	25
Coaster bus	hr/month	100
Dewatering pumps	l/sec	150

The summary of machine hours for all mobile plant is provided in Table 5.34.

Table 5.34 Summary of machine hours

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Primary fleet																		
Digger hours 180 t	hrs	0	565	8,731	11,776	13,843	13,818	13,625	13,950	10,872	5,901	2,945	1,348	64	0	0	0	97,438
Digger hours 150 t	hrs	957	3,285	2,329	2,509	2,691	2,572	2,714	2,645	1,649	438	717	963	1,229	1,251	1,140	603	27,690
Truck hours 90 t	hrs	5,025	19,051	38,718	51,250	75,690	70,511	64,475	65,692	58,199	35,691	22,619	10,078	3,175	3,038	2,911	2,412	528,535
Blasthole drilling	hrs	128	543	2,459	3,697	4,398	6,015	8,267	8,131	9,317	5,544	2,756	871	27	0	0	0	52,153
RC drilling	hrs	206	864	3,345	4,869	6,076	8,753	11,510	12,193	14,119	8,574	4,278	1,311	33	0	0	0	76,132
Ancillary fleet																		
Track dozer	hrs	835	2,177	4,866	6,418	7,714	8,154	7,944	8,039	6,275	3,241	1,841	1,197	597	550	501	1,590	61,940
Wheel dozer	hrs	0	215	2,433	3,143	3,637	3,606	3,595	3,651	2,755	1,395	806	508	284	275	251	133	26,686
Grader	hrs	421	1,694	4,866	6,285	7,275	7,211	7,189	7,302	5,509	2,789	1,611	1,017	569	550	501	265	55,056
Water cart	hrs	631	2,416	5,379	6,837	7,867	7,777	7,786	7,884	5,872	2,885	1,769	1,229	839	826	752	398	61,148
Batter digger	hrs	105	423	1,217	1,571	1,819	1,803	1,797	1,825	1,377	697	403	254	142	138	125	66	13,764
Rock breaker	hrs	0	48	288	288	288	288	288	288	288	288	288	288	288	288	190	0	3,694
Stemming truck	hrs	45	190	619	868	1,031	1,193	1,433	1,374	1,321	742	369	137	5	0	0	0	9,328
Lighting towers	hrs	2,184	10,872	17,328	17,328	17,328	17,376	17,328	17,328	17,328	17,376	17,328	17,328	17,328	17,376	17,328	8,640	247,104
Fuel and lube truck	hrs	121	497	1,255	1,566	1,787	1,904	2,026	2,058	1,844	1,143	756	529	395	390	379	224	16,873
Minor equipment																		
IT carrier with forks	hrs	0	300	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	525	300	300	0	13,425
Tyre handler	hrs	0	600	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	1,050	600	600	0	26,850
Backhoe	hrs	0	60	240	240	240	240	240	240	240	240	240	240	105	60	60	0	2,685
Skidsteer loader	hrs	0	60	240	240	240	240	240	240	240	240	240	240	105	60	60	0	2,685

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Standpipe	hrs	0	600	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	2,400	1,050	600	600	0	26,850
Mobile workshop crane 25 t	hrs	0	150	600	600	600	600	600	600	600	600	600	600	263	150	150	0	6,713
Dewatering pumps	hrs	310	1,100	1,417	1,752	1,929	4,580	5,094	5,094	5,708	10,035	11,411	15,758	3,373	0	0	0	67,560

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Light vehicles																		
Single cab utes	hrs	0	5,400	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	9,600	6,900	6,000	6,000	0	120,300
Twin cab utes	hrs	300	1,500	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	3,000	1,200	600	600	0	34,200
Land Cruiser	hrs	300	975	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,050	900	900	0	19,125
Coaster bus	hrs	0	1,500	2,400	2,400	3,600	3,600	3,600	3,600	3,000	2,400	1,200	1,200	1,200	1,200	1,200	0	32,100

5.8.2 Labour

The mining operation at Tulu Kapi will operate three shifts per day of 8 hours duration each, 7 days per week. Shift work will require a four-panel roster similar to the one shown in Figure 5.58.

Figure 5.58 Example of four-panel roster running three 8-hour shifts per day

	Week 1							Week 2							Week 3							Week 4						
	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S
Panel 1	A	A	A	A	A	R	D	D	D	D	D	R	R	N	N	N	N	N	R	R	A	A	A	A	A	R	D	D
Panel 2	N	N	N	R	R	A	A	A	A	A	R	D	D	D	D	D	R	R	N	N	N	N	N	R	R	A	A	A
Panel 3	D	R	R	N	N	N	N	N	R	R	A	A	A	A	A	R	D	D	D	D	D	R	R	N	N	N	N	N
Panel 4	R	D	D	D	D	D	R	R	N	N	N	N	N	R	R	A	A	A	A	A	R	D	D	D	D	D	R	R

D day shift
A afternoon shift
N night shift
R rest day

The workforce was determined based on equipment numbers and operating hours. All primary and ancillary equipment were assumed to be fully manned. Maintenance labour was determined by factoring equipment hours. Management and technical services labour was based on experience.

Provision was made within the estimate for additional labour to cover for annual leave, sick leave and absenteeism ("ASLA"). Five days sick leave was allowed for and up to 60 days ASLA was allowed for per year for key workforce positions such as operators and fitters. This represents an approximate 30% increase in labour cost to cover these positions.

Labour costs were based on findings of the Salary Survey Report (Meyer Hoskings & Associates, 2015). Labour costs include provision for the following on-costs:

- Annual leave (21 days for staff, 16 days for workers) with two additional days allowed for on average length of service
- Accident and illness insurance (3.5%)
- Social security provisions (11%)
- Vacation allowance (8% local employees only)
- 13th Cheque bonus (one month's gross salary)
- Airfares for expats.

The labour cost build-up for each of the key positions is given in Table 5.35 and the annual labour schedule is provided in
Table 5.36.

Table 5.35 Mine labour cost build-up

Position	Max. no.	Job grade	Source	Standard work days per year	Actual annual work days	Annual base salary	Group personal accident and illness insurance	Social security	Vacation allowance – Ethiopian Nationals only	13th cheque (1 month's base salary) Ethiopian Nationals only	Airfares per year	Total annual cost	Total quarterly cost
Mining Management													
Mine Manager	1	E3	Expat2	260	236	260,000	9,100	28,600	0	0	10,944	308,644	77,161
Mine Administrative Assistant	1	C1	Local	260	232	12,089	423	1,330	967	1,234	0	16,044	4,011
Mine Technical Service Department											0		
Technical Services Superintendent	1	D4	Expat2	260	236	210,000	7,350	23,100	0	0	10,944	251,394	62,849
Mine Technical Services Clerk	1	B1	Local	260	232	5,215	183	574	417	532	0	6,921	1,730
Senior Mining Engineer	1	D4	Expat1	260	234	78,392	2,744	8,623	0	0	6,882	96,641	24,160
Mining Engineer – Production	2	D2	Local	260	232	27,398	959	3,014	2,192	2,797	0	36,359	9,090
Mining Engineer – Drill and Blast	2	D2	Local	260	232	27,398	959	3,014	2,192	2,797	0	36,359	9,090
Chief Geologist	1	D5	Expat2	260	234	230,000	8,050	25,300	0	0	10,944	274,294	68,574
Senior Mine Geologist	1	D4	Expat1	260	234	78,392	2,744	8,623	0	0	6,882	96,641	24,160
Mine Geologist	3	D1	Local	260	232	23,273	815	2,560	1,862	2,376	0	30,886	7,721
Senior Mine Technician	0	B4	Local	260	232	9,759	342	1,073	781	996	0	12,951	3,238
Mine Technician/Sampler	16	B1	Local	260	232	5,215	183	574	417	532	0	6,921	1,730
Senior Mine Surveyor	1	D2	Expat1	260	234	47,200	1,652	5,192	0	0	6,882	60,926	15,232
Mine Surveyor	3	C4	Local	260	232	18,787	658	2,067	1,503	1,918	0	24,932	6,233
Survey Assistants	3	B1	Local	260	232	5,215	183	574	417	532	0	6,921	1,730

Position	Max. no.	Job grade	Source	Standard work days per year	Actual annual work days	Annual base salary	Group personal accident and illness insurance	Social security	Vacation allowance – Ethiopian Nationals only	13th cheque (1 month's base salary) Ethiopian Nationals only	Airfares per year	Total annual cost	Total quarterly cost
Database Administrator	1	C3	Local	260	232	16,879	591	1,857	1,350	1,723	0	22,400	5,600

Position	Max. no.	Job grade	Source	Standard work days per year	Actual annual work days	Annual base salary	Group personal accident and illness insurance	Social security	Vacation allowance – Ethiopian Nationals only	13th cheque (1 month's base salary) Ethiopian Nationals only	Airfares per year	Total annual cost	Total quarterly cost
Mine Operations											0		
Mine Operations Superintendent	1	D4	Expat2	260	235	210,000	7,350	23,100	0	0	10,944	251,394	62,849
Deputy Mine Operations Superintendent (Training)	1	C5	Expat1	260	234	33,600	1,176	3,696	0	0	6,882	45,354	11,339
Mining General Supervisor	1	D2	Expat1	260	234	47,200	1,652	5,192	0	0	6,882	60,926	15,232
Production Supervisors – Shift	4	C3	Expat1	260	234	27,960	979	3,076	0	0	6,882	38,896	9,724
Mine Trainer	1	C3	Expat1	260	234	27,960	979	3,076	0	0	6,882	38,896	9,724
Drill and Blast Supervisor	2	C4	Expat1	260	235	30,545	1,069	3,360	0	0	6,882	41,856	10,464
Mine Reporting Clerks	2	A3	Local	260	237	3,365	118	370	269	343	0	4,465	1,116
Excavator Operator	15	B4	Local	260	177	9,759	342	1,073	781	996	0	12,951	3,238
Truck Operator	52	B3	Local	260	177	8,768	307	964	701	895	0	11,636	2,909
Blast Crew – Day Shift	10	B4	Expat1	260	179	14,916	522	1,641	0	0	6,882	23,960	5,990
Drill Operator	24	B4	Expat1	260	179	14,916	522	1,641	0	0	6,882	23,960	5,990
Dozer Operator	10	B4	Local	260	177	9,759	342	1,073	781	996	0	12,951	3,238
Grader Operator	6	B4	Local	260	177	9,759	342	1,073	781	996	0	12,951	3,238
Water Cart/other ancillary	8	B2	Local	260	177	7,448	261	819	596	760	0	9,884	2,471
Day-Shift Operators	6	B3	Local	260	177	8,768	307	964	701	895	0	11,636	2,909
Annual leave plus sick coverage – Mine Operations	61	B3	Local	260	237	8,768	307	964	701	895	0	11,636	2,909

Position	Max. no.	Job grade	Source	Standard work days per year	Actual annual work days	Annual base salary	Group personal accident and illness insurance	Social security	Vacation allowance – Ethiopian Nationals only	13th cheque (1 month's base salary) Ethiopian Nationals only	Airfares per year	Total annual cost	Total quarterly cost
Mine Maintenance											0		
Mine Maintenance Superintendent	1	D4	Expat2	260	235	210,000	7,350	23,100	0	0	10,944	251,394	62,849
Mine Maintenance Supervisor	1	D2	Expat1	260	234	47,200	1,652	5,192	0	0	6,882	60,926	15,232
Product Specialist	1	D2	Expat1	260	234	47,200	1,652	5,192	0	0	6,882	60,926	15,232
Mine Maintenance Planner	1	D1	Expat1	260	234	44,700	1,565	4,917	0	0	10,944	62,126	15,531
Mine Maintenance Planner (Training)	2	C4	Expat1	260	234	30,545	1,069	3,360	0	0	10,944	45,918	11,480
Maintenance Leading Hands – Shift	4	C3	Local	260	232	16,879	591	1,857	1,350	1,723	0	22,400	5,600
Mine Maintenance Clerk	1	B1	Local	260	232	5,215	183	574	417	532	0	6,921	1,730
Auto Electrician	1	C1	Expat1	260	224	24,273	850	2,670	0	0	10,944	38,736	9,684
Welder	4	B4	Expat1	260	174	14,916	522	1,641	0	0	10,944	28,022	7,006
Machinist	1	B4	Expat1	260	174	14,916	522	1,641	0	0	10,944	28,022	7,006
Fitters – Shift	28	B4	Expat1	260	174	14,916	522	1,641	0	0	10,944	28,022	7,006
Fitters – Day	0	B4	Local	260	172	9,759	342	1,073	781	996	0	12,951	3,238
Trades Assistants	12	B1	Local	260	172	5,215	183	574	417	532	0	6,921	1,730
Tool Storekeeper	2	B1	Local	260	172	5,215	183	574	417	532	0	6,921	1,730
Parts Storekeeper	2	B2	Local	260	172	7,448	261	819	596	760	0	9,884	2,471
Yardman	2	B1	Local	260	172	5,215	183	574	417	532	0	6,921	1,730
Annual leave plus sick coverage	26	B2	Local	260	232	7,448	261	819	596	760	0	9,884	2,471

Position	Max. no.	Job grade	Source	Standard work days per year	Actual annual work days	Annual base salary	Group personal accident and illness insurance	Social security	Vacation allowance – Ethiopian Nationals only	13th cheque (1 month's base salary) Ethiopian Nationals only	Airfares per year	Total annual cost	Total quarterly cost
– Maintenance													

Table 5.36 Mine labour schedule

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Max.
Mining Management																		
Mine Manager	No.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Mine Administrative Assistant	No.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Mine Technical Service Department																		
Technical Services Superintendent	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Mine Technical Services Clerk	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Senior Mining Engineer – Long-term planning	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Mining Engineer – Production	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2
Mining Engineer – Drill and blast	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2
Chief Geologist	No.	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Senior Mine Geologist	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Mine Geologist	No.	0	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	3
Senior Mine Technician	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mine Technician/Sampler	No.	4	4	5	6	8	14	14	15	16	12	6	4	4	0	0	0	16
Senior Mine Surveyor	No.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Mine Surveyor	No.	0	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	3

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Max.
Survey Assistants	No.	1	3	3	3	3	3	3	3	3	3	3	3	3	1	1	0	3
Database Administrator	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Mine Operations																		
Mine Operations Superintendent	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Deputy Mine Operations Superintendent (Training)	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Mining General Supervisor	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Production Supervisors – Shift	No.	0	4	4	4	4	4	4	4	4	4	4	4	4	4	4	0	4
Mine Trainer	No.	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1
Drill and Blast Supervisor	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2
Mine Reporting Clerks	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2
Excavator Operator	No.	5	6	12	12	14	14	14	14	14	7	4	4	4	4	4	4	14
Truck Operator	No.	20	20	36	48	52	52	52	52	48	32	20	12	4	4	4	4	52
Blast Crew – Day shift	No.	2	2	6	6	8	10	10	10	10	6	4	2	2	0	0	0	10
Drill Operator	No.	4	4	8	9	12	22	22	23	24	18	9	4	4	0	0	0	24
Dozer Operator	No.	0	5	7	8	9	10	10	10	9	5	4	4	4	0	0	0	10
Grader Operator	No.	0	4	5	5	6	6	6	6	6	4	4	4	4	0	0	0	6
Water Cart/other ancillary	No.	0	4	6	7	8	8	8	8	8	4	4	4	4	0	0	0	8
Day Shift Operators	No.	0	6	6	6	6	6	6	6	6	6	6	6	6	0	0	0	6
Annual leave plus sick coverage – Mine Operations	No.	15	24	41	48	54	60	60	60	59	39	26	19	15	4	4	4	60
Mine Maintenance																		
Mine Maintenance Superintendent	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Mine Maintenance Supervisor	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Max.
Product Specialists	No.	0	1	1	1	1	1	1	1	1	1	1	1	0	0	0	0	1
Mine Maintenance Planner	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Mine Maintenance Planner (Training)	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	1	1	0	2
Maintenance Leading Hands – Shift	No.	0	4	4	4	4	4	4	4	4	4	4	4	4	1	1	0	4
Mine Maintenance Clerk	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Auto Electrician	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Welder	No.	0	4	4	4	4	4	4	4	4	4	4	4	4	0	0	0	4
Machinist	No.	0	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Fitters – Shift	No.	0	8	20	20	24	24	24	28	28	16	12	8	4	4	4	4	28
Fitters – Day	No.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trades Assistants	No.	0	4	8	12	12	12	12	12	12	8	8	4	4	4	4	4	12
Tool Storekeeper	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	1	1	0	2
Parts Storekeeper	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2
Yardman	No.	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	2
Annual leave plus sick coverage – Maintenance	No.	7	12	20	22	24	24	24	26	26	18	16	12	10	5	5	5	26
Total labour	**No.**	**74**	**160**	**237**	**264**	**294**	**319**	**319**	**327**	**323**	**232**	**180**	**144**	**127**	**41**	**41**	**25**	**327**

5.8.3 Materials

Consumables will be required LOM for the mine operations. Some of the materials costs associated with the operation of the mobile mining fleet are covered in Section 5.8.1.1 and are not readdressed here. These include the following:

- Diesel fuel
- Oils and lubricants
- Tyres
- GET.

5.8.3.1 Drill consumables

Provision was made for drill consumables for both the THH production drill and the DTH RC drill. A unit cost per metre was applied to the estimated drill metres for each machine in each of the three rock types (saprolite, fresh and hard). The cost per metre was derived from expected life of drill consumables and unit cost provided by vendors. A summary of the drill consumable cost is provided below in Table 5.37 and in detail in **Error! Reference source not found.**. The drill metres shown were based on the blasting pattern sizes which incorporate the drilling from RC.

Table 5.37 Drill consumables costs

Description	Units	Quantity	Rate	Total ($M)
THH 115 mm	m	359,637	1.37	0.49
THH 115 mm	m	555,676	2.65	1.47
THH 115 mm	m	395,839	3.17	1.26
RC DTH 114	m	473,367	4.45	2.10
RC DTH 114	m	649,385	8.47	5.50
RC DTH 114	m	499,007	11.72	5.85
Total				**16.68**

5.8.3.2 Explosives direct costs

Blast patterns were based on fragmentation analysis conducted by Itasca (**Error! Reference source not found.**). The blast patterns were selected to provide fragmentation with 98% passing 600 mm, aperture of the grizzly ROM bin. These patterns were applied to all ore zones and selective waste zones adjacent to the ore. Lower powder factors were used for bulk waste zones. A summary of the drill and blast parameters used in given in Table 5.38.

Table 5.38 Drill and blast parameters

Material type	Units	Classification								
		Bulk			Selective waste			Ore		
		Saprolite	Fresh	Hard	Saprolite	Fresh	Hard	Saprolite	Fresh	Hard
Material density	t/bcm	2.74	2.80	2.80	2.74	2.80	2.80	2.74	2.80	2.80
Hole diameter	mm	114.0	114.0	114.0	114.0	114.0	114.0	114.0	114.0	114.0
Bench height	m	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50	7.50
Sub-drill	m	0.50	0.75	0.75	0.50	0.75	0.75	0.50	0.75	0.75
Fall back	m	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30	0.30
Stemming	m	2.50	2.30	2.30	2.50	2.30	2.30	2.50	2.30	2.30
Product density	g/cc	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
Powder factor	kg/bcm	**0.30**	**0.60**	**0.70**	**0.35**	**0.71**	**0.85**	**0.35**	**0.71**	**0.85**
Powder factor	kg/t	0.11	0.21	0.25	0.13	0.25	0.30	0.13	0.25	0.30
Stemming density	t/m^3	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10	2.10
Spillage factor		10%	10%	10%	10%	10%	10%	10%	10%	10%
Mass of stemming	kg/hole	58.95	54.23	54.23	58.95	54.23	54.23	58.95	54.23	54.23
Unit charge weight	kg/m	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25	12.25
Charge weight	kg/hole	67.37	72.88	72.88	67.37	72.88	72.88	67.37	72.88	72.88
Yield	bcm/hole	224.55	121.46	104.11	192.48	102.65	85.74	192.48	102.65	85.74
Yield	t/hole	615.28	340.10	291.51	527.38	287.41	240.07	527.38	287.41	240.07
Blasthole factor	holes/t	0.0016	0.0029	0.0034	0.0019	0.0035	0.0042	0.0019	0.0035	0.0042
B:S ratio	ratio	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15
Burden	m	5.1	3.7	3.5	4.7	3.4	3.1	4.7	3.4	3.1
Spacing	M	5.9	4.3	4.0	5.4	4.0	3.6	5.4	4.0	3.6
Face hole provision	%	2%	2%	2%	2%	2%	2%	2%	2%	2%
Specific drilling	t/m drill	72.65	38.98	33.41	62.27	32.94	27.52	62.27	32.94	27.52

Explosive direct costs include all the materials associated with charging a standard blast hole as given in **Error! Reference source not found.** below. The fixed costs associated with the downhole delivery service are discussed under Section 5.8.4.

Table 8.12 Blasthole charging summary

Model	Units	Rate	Saprolite	Fresh	Hard
Booster 250 g	each	5.68	1	1	1
Det 9 m	each	5.23	1	1	1
Surface Delay 5 m	each	4.41	-	1	1
Surface Delay 9 m	each	5.18	1	-	-
Wastage	%	5%	16	15	15
Subtotal initiating explosives	**hole**		**$16.90**	**$16.09**	**$16.09**
S100 Emulsion on site	kg	1.77	67.37[1]	72.88	72.88
Stemming	kg	0.02	58.95	54.23	54.23
Wastage	%	5%	121	130	130
Subtotal bulk products	**hole**		**$126.59**	**$136.74**	**$136.74**
Total cost	**hole**		**$143.49**	**$152.83**	**$152.83**
No. of blastholes	m		98,410	138,180	102,602
Total cost ($M)	$M		14.12	21.12	15.68
Total cost ($M)	**$M**			**50.92**	

Note: [1] Stemming for the saprolite was increased to account for the increase in burden and the lower density of material, hence explosive column will be shorter and require less emulsion.

5.8.3.3 Stemming and road base

It was estimated approximately 300,000 t of aggregate will be required for use as roadbase and stemming. Aggregate will be produced at a dedicated crushing and screening plant located adjacent to the process plant. A provision of $10/t was allowed for the operation of the plant to produce aggregate. An additional $20/t was allowed for the cost of finer aggregates required for stemming material.

5.8.4 Contracts and services

The project will require various contractor services to support the main operation. Provisions for these are described below.

5.8.4.1 Explosive delivery service

In addition to the explosive costs set out in Section 0, fixed charges will be incurred for the provision of the fixed and mobile plant associated with the service; these are shown in Table 5.39.

Table 5.39 Explosives indirect fixed costs

Description	Unit	Quantity	Rate	Total ($M)
Capital recovery charge for plant	month	138	30,070	4.15
Capital recovery charge for storage only	month	138	13,835	1.91
Monthly DTH service to suit estimated volumes	month	138	23,119	3.19
Total LOM				**9.25**

5.8.4.2 Sampling and assaying

Samples collected from RC grade control drilling will be assayed at the on-site lab. An allowance of $10 per assay was included to cover the costs of this work. In addition an allowance of $500 per month was included for grade control consumables such as marking out paint, bags and other miscellaneous materials.

5.8.4.3 General fixed cost overheads

The general operating expenses associated with the office are covered under the administration costs estimate compiled by SENET. Provision was however included for mining specific overheads and these are summarised in Table 5.40.

The mining tech services were applied for the duration of the excavation activity following completion of the borrow pit. General mining expenses were applied for the duration of the load and haul activity following completion of the borrow pit, reduced costs were applied during the period of stockpile re-handle at the end of the project. The mine workshop expenses were applied in full for the duration of the load and haul activity, including the period of borrow pit works and low grade stockpile re-handle.

Table 5.40 Mining specific overheads

Description	Unit	Quantity	Rate	Total ($M)
Mining technical services				
Software licenses	Month	126	10,000	1.26
Consultants (geotechnical etc.)	Month	126	20,000	2.52
Airfares and accommodation (work related)	Month	126	20,000	2.52
Training courses	Month	126	3,000	0.38
General mining expense provisions				
Miscellaneous consumables	Month	134	3,000	0.40
Subcontractors – miscellaneous	Month	134	5,000	0.67
Equipment hire	Month	134	20,000	2.69
Freight and courier	Month	134	5,000	0.67
Safety equipment	Month	134	20,000	2.69
Mine workshop				
Consumables and tools	Month	165	5,000	0.83
Hydrocarbon management	Month	165	2,000	0.33
Subcontractors and artisans	Month	165	5,000	0.83
Total				**15.77**

5.8.4.4 Earthmoving subcontracts

Site preparation works were costed as subcontract services. This included the preparation of both the excavation and dumping footprints and involved clearing and grubbing as well as the removal and stockpiling of topsoil.

The base of the waste dumps will also require the installation of drainage structures to divert and control rainfall runoff around the dumps and prevent damming of water behind the dump and minimise percolation through the dump.

The contractor costs for this work were provided by Golder from the 2015 report entitled “Tulu Kapi North, West, and South Mine Waste Dump Design Report” and provisions within the estimate are summarised in Table 5.41.

Table 5.41 Earthmoving contractor costs

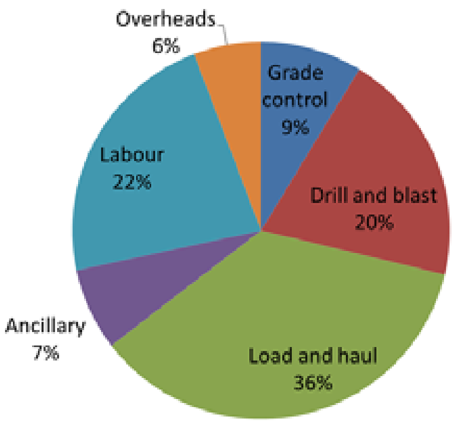
Description	Unit	Quantity	Rate	Total
Site preparation				
Clearing and grubbing	hectare	238	5,600.00	1.33
Topsoil removal	hectare	238	11,200.00	2.67
Sediment pond and ancillary structures				
Excavate to grade to form sediment pond and outlet channel	m^3	28,938	7.40	0.21

Place and compact selected waste rock to form sediment pond outlet structure	m^3	1,085	9.83	0.01
Underdrains				
Excavate to spoils grade 0.5 m depth channel along underdrains alignment	m^3	9,301	7.40	0.07
Supply and install 340 g/m^2 non-woven needle punched A6 geotextile	m^2	44,510	4.87	0.22
Subtotal				**4.51**
Contingency	%	10%		0.45
Total				**4.96**

5.8.5 Mine operating cost summary

The total mine operating costs, based on an owner operated scenario, was estimated to be $359M for the LOM. Based on a total material movement of 134 Mt, the unit operating cost was estimated to be $2.68/t. This compares to the 2014 preliminary owner cost estimate by Snowden of $2.79 and is therefore within 5% of the previous estimate that also allowed for new equipment. The distribution of operating costs is shown in Figure 5.59 and Table 5.42 provides a summary of the operating expense schedule for the LOM.

Figure 5.59 Distribution of mine operating costs



Reallocation of $15.6M in preproduction costs into the capital development classification provided a reduced the unit operating to $2.56/t.

Table 5.42 Mine operating cost schedule

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Primary fleet																		
Excavator 180 t	$M	-	0.18	2.71	3.66	4.30	4.29	4.23	4.33	3.38	1.83	0.91	0.42	0.02	-	-	-	30.25
Excavator 150 t	$M	0.23	0.77	0.55	0.59	0.63	0.61	0.64	0.62	0.39	0.1	0.17	0.23	0.29	0.29	0.27	0.14	6.53
Truck 90 t	$M	0.84	3.2	6.5	8.61	12.71	11.84	10.83	11.03	9.77	5.99	3.8	1.69	0.53	0.51	0.49	0.41	88.75
Blasthole drilling	$M	0.02	0.09	0.42	0.64	0.76	1.04	1.42	1.40	1.61	0.96	0.47	0.15	0.00	-	-	-	8.99
RC drilling	$M	0.04	0.17	0.66	0.96	1.20	1.72	2.27	2.40	2.78	1.69	0.84	0.26	0.01	-	-	-	14.99
Ancillary fleet																		
Track dozer	$M	0.1	0.26	0.59	0.77	0.93	0.98	0.96	0.97	0.76	0.39	0.22	0.14	0.07	0.07	0.06	0.19	7.46
Wheel dozer	$M	-	0.03	0.35	0.45	0.52	0.52	0.52	0.52	0.4	0.2	0.12	0.07	0.04	0.04	0.04	0.02	3.83
Grader	$M	0.03	0.11	0.32	0.41	0.48	0.47	0.47	0.48	0.36	0.18	0.11	0.07	0.04	0.04	0.03	0.02	3.6
Water cart	$M	0.05	0.19	0.42	0.54	0.62	0.61	0.61	0.62	0.46	0.23	0.14	0.1	0.07	0.07	0.06	0.03	4.83
Batter digger	$M	0.01	0.05	0.15	0.2	0.23	0.23	0.23	0.23	0.17	0.09	0.05	0.03	0.02	0.02	0.02	0.01	1.74
Rockbreaker	$M	-	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	-	0.5
Stemming truck	$M	0	0.01	0.05	0.07	0.08	0.1	0.11	0.11	0.11	0.06	0.03	0.01	0	-	-	-	0.74
Lighting towers	$M	0.01	0.06	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.05	1.35
Fuel and lube truck	$M	0.01	0.04	0.09	0.12	0.13	0.14	0.15	0.15	0.14	0.09	0.06	0.04	0.03	0.03	0.03	0.02	1.27
Minor equipment																		
IT carrier with forks	$M	-	0.02	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.03	0.02	0.02	-	0.78
Tyre handler	$M	-	0.03	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.06	0.03	0.03	-	1.56
Backhoe	$M	-	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-	0.10
Skidsteer loader	$M	-	0.00	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	-	0.07
Standpipe	$M	-	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.01	0.01	-	0.41
Mobile workshop crane 25 t	$M	-	0.01	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.01	0.01	-	0.43

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Dewatering pumps	$M	0.03	0.09	0.12	0.15	0.16	0.38	0.42	0.42	0.47	0.83	0.95	1.31	0.28	-	-	-	5.6
Light vehicles																		
Single cab utes	$M	-	0.20	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.25	0.22	0.22	-	4.39
Twin cab utes	$M	0.01	0.04	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.03	0.02	0.02	-	0.98
Land Cruiser	$M	0.02	0.05	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.05	0.05	0.05	-	1.00
Coaster bus	$M	-	0.04	0.06	0.06	0.10	0.10	0.10	0.10	0.08	0.06	0.03	0.03	0.03	0.03	0.03	-	0.85
Total plant operating cost	$M	0.90	4.19	14.14	18.38	24.03	24.23	24.20	24.61	21.96	13.64	8.88	5.58	2.16	1.71	1.63	1.15	191.38
Production drilling consumables	$M	0.01	0.03	0.16	0.23	0.28	0.38	0.52	0.50	0.56	0.33	0.16	0.05	0.00	-	-	-	3.22
RC drilling consumables	$M	0.04	0.15	0.58	0.85	1.06	1.54	2.03	2.16	2.52	1.53	0.77	0.23	0.01	-	-	-	13.46
Explosives	$M	0.24	0.97	3.26	4.6	5.48	6.43	7.86	7.48	7.29	4.09	2.04	0.74	0.03	-	-	-	50.52
Road base	$M	0.02	0.08	0.21	0.33	0.51	0.45	0.37	0.34	0.33	0.2	0.13	0.04	0.01	0.01	0.01	-	3.07
Total materials cost	$M	0.31	1.24	4.21	6.01	7.33	8.8	10.78	10.49	10.7	6.16	3.1	1.07	0.05	0.01	0.01	-	70.27
Mining management	$M	0.16	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	0.32	-	4.70
Mine technical service dept.	$M	0.18	0.57	1.17	1.18	1.19	1.21	1.24	1.25	1.25	1.21	1.18	1.17	0.42	0.16	0.16	-	13.54
Operators	$M	0.15	0.86	2.04	2.46	2.8	2.99	3.25	3.26	2.89	2.05	1.64	1.32	0.72	0.55	0.55	0.07	27.61
Mine maintenance	$M	0.08	0.88	1.52	1.64	1.84	1.84	1.84	1.91	1.8	1.47	1.3	1.14	0.68	0.56	0.56	0.09	19.16
Total labour cost	$M	0.57	2.64	5.05	5.6	6.16	6.37	6.66	6.74	6.26	5.05	4.44	3.95	2.14	1.6	1.6	0.17	65.02
Explosive delivery service	$M	0.20	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.20	-	-	-	9.25
Assay and consumables	$M	0.04	0.15	0.26	0.42	0.34	0.21	0.34	0.28	0.36	0.24	0.12	0.05	0.01	-	-	-	2.83
Technical support and training	$M	-	0.16	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.16	-	-	-	6.68
General mining expenses	$M	-	0.16	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.64	0.28	0.16	0.16	-	7.12
Mine workshop	$M	-	0.11	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	-	1.98
Total mining overheads	$M	0.24	1.38	2.48	2.64	2.56	2.44	2.56	2.5	2.58	2.46	2.34	2.27	0.79	0.3	0.3	-	27.85

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Clearing and grubbing	$M	0.36	0.27	-	0.15	0.22	0.19	0.13	0.07	0.03	-	-	0.05	-	-	-	-	1.47
Topsoil removal	$M	0.72	0.53	-	0.3	0.45	0.39	0.25	0.14	0.06	-	-	0.09	-	-	-	-	2.93
Waste dump underdrainage	$M	0.24	-	-	0.22	-	-	-	0.1	-	-	-	-	-	-	-	-	0.56
Total mining overheads	$M	1.33	0.8	-	0.67	0.67	0.58	0.38	0.32	0.09	-	-	0.14	-	-	-	-	4.96
TOTAL MINE OPERATING COST	**$M**	3.85	11.73	25.69	33.09	40.51	42.15	44.28	44.38	41.45	27.31	18.71	12.93	5.01	3.5	3.42	1.05	359.07

5.9 CAPITAL COSTS

5.9.1 Equipment capital costs

Mining capital costs were estimated from OEM vendor quotations. Requests for budget quotation were issued to recognised vendors with in-country representation:

- NEFC Caterpillar
- Moenco – Komatsu
- Liebherr Export AG
- Hagbes – Hitachi
- Atlas Copco Eastern Africa Limited
- Advanced mining UAE – Sandvik
- AEL Explosives.

Both capital and operating costs were request from the vendors and responses were received from most of those listed, however, where a company was unable to provide operating costs the quotations were set aside.

The capital estimate allows for the majority of the earthmoving equipment to be purchased from Komatsu with blasthole drills to be sourced from Atlas Copco. Minor equipment were sourced from a variety of locations throughout the world.

A summary of the capital equipment cost build-up is given in Table 5.43.

5.9.1.1 Transport and logistics

The capital costs allow for transport to site and commissioning.

All imported equipment will be shipped into the Port of Djibouti in the neighbouring country of Djibouti. From there they will be transported by road via the border crossing at Galafi to Addis Ababa then on to site at Tulu Kapi. Road transport distances will be dependent on the size of the components. In-gauge equipment can travel through Addis Abbaba then on to site, a distance of approximately 1,400 km from the port. Larger equipment will need to bypass Addis Ababa, extending the route by to approximately 1,800 km from the port.

Only one vendor (Caterpillar) provided fully costed equipment delivery, landed to site. These costs were used to estimate transport costs for other equipment on a pro rata of distance and weight basis.

Nominal cost provisions were allowed by Caterpillar for the assembly of larger equipment on site. This covered the cost of specialist labour required for the task. Cranage and accommodation were assumed to be provided by KEFI.

5.9.1.2 Explosive magazine

The magazine infrastructure will be provided by the explosive vendor as part of the down hole service. The costs will be recovered as a monthly fee for the infrastructure. The costs do not include site preparations and any concrete required.

An estimate was compiled for the preparation of the surface magazine and emulsion manufacturing facility including site preparation and compaction, fencing, earth bunds and concrete. Costs were taken from unit costs used in the SENET estimate for other infrastructure.

The total estimated cost to prepare the magazine site for the contractor was $623,000.

5.9.1.3 Other equipment capital cost provisions

Other provisions were made within the capital equipment estimate which is not shown in Table 5.43:

- All major equipment to be fitted with aftermarket fire suppression systems
- A contingency allowance of 10% was included for unpriced machine options and accessories that will be required for the efficient running of the machine
- A separate allowance of $2.24M was included for storeroom first fills of machinery spare parts
- Small crushing and screening facility for the manufacture of aggregates for roadbase and stemming at a cost of $819,000
- Small flatbed stores trucks were allowed for at $35,000 each
- Up to three dewatering pumps and discharge line $794,000 in total and will be staged based on estimated inflows
- Workshop tooling provision of $200,000
- Sea containers for storage (three at $3,000 each)
- Survey equipment $100,000
- Surpac or equivalent resource modelling and mine design software (three licenses at $25,000 per license)
- Minesched or equivalent scheduling software one license at $50,000
- Miscellaneous technical software $10,000
- General provision for miscellaneous items not priced of $50,000.

Table 5.43 Capital equipment cost build up

Description	Size/Class	Make	Model	Supplier	FOB port of dispatch	Sea freight to Djibouti[1]	Road transport to Tulu Kapi[1]	Assembly and commissioning[1]	Fire suppression[1] systems	Contingency	Total cost per machine
Komatsu											
Excavator – backhoe	200 t	Komatsu	PC2000-8	MOENCO	1,820,747	109,000	90,569	50,000	52,876	212,319	2,335,511
Rigid body dump truck	90 t	Komatsu	HD785-7	MOENCO	974,154	39,900	75,606	35,000	27,720	115,238	1,267,618
Excavator – backhoe	120 t	Komatsu	PC1250-8R	MOENCO	757,959	66,000	76,909	35,000	41,808	97,768	1,075,444
Rigid body dump truck	55 t	Komatsu	HD465-7R	MOENCO	510,801	33,000	42,337	0	21,826	60,796	668,761
Front-end loader	6.4 m3	Komatsu	WA600-6R	MOENCO	521,507	22,000	40,327	0	27,720	61,155	672,710
Wheel dozer	11.5 m3	Komatsu	WD600-3A	MOENCO	461,370	20,000	37,963	0	21,826	54,116	595,274
Track dozer	17' Blade	Komatsu	D375A-5	MOENCO	626,213	31,000	41,753	5,000	27,720	73,169	804,855
Track dozer	15' Blade	Komatsu	D275A-5	MOENCO	440,769	15,000	33,283	5,000	27,720	52,177	573,949
Water cart – rigid[2]	30 kl	Kom/Groundforce	HD325-7 No Body	MOENCO	514,579	67,000	26,643	25,000	21,826	65,505	720,553
Grader	16 ft	Komatsu	GD825-2	MOENCO	386,394	19,000	21,884	0	21,826	44,910	494,015
Excavator – backhoe	43 t	Komatsu	PC450-8R	MOENCO	222,450	26,000	27,588	0	27,720	30,376	334,134
Rock breaker	43 t	Komatsu	PC450-8R cw H180E S Hammer	MOENCO	323,330	28,000	30,457	0	27,720	40,951	450,458
Tool carrier	14 t lift	Komatsu	WA380-5	MOENCO	252,171	83,000	16,619	5,000	19,383	37,617	413,791
Tyre handler	14 t lift	Komatsu	WA380-5	MOENCO	328,171	87,000	16,619	5,000	19,383	45,617	501,791
Skidsteer loader	1.7 t lift	Komatsu	SK820-5E0	MOENCO	45,970	3,000	13,740	0	18,664	8,137	89,512
Backhoe	8.2 t	Komatsu	WB97R-5E0	MOENCO	84,979	9,000	13,880	0	18,664	12,652	139,175
Fuel truck – rigid[2]	19 kl	Kom/Groundforce	HD325-7 No Body	MOENCO	729,579	67,000	42,337	25,000	21,826	88,574	974,316
Atlas Copco											
Top hammer drill	25 kW	Atlas Copco	T45-10	Atlas Copco Eastern Africa Limited	650,000	18,000	22,188	0	27,720	150,761	868,669
RC drill	435 psi @ 995 cfm	Atlas Copco	D65 - RC	Atlas Copco Eastern Africa Limited	1,250,000	18,000	22,188	0	27,720	276,761	1,594,669
Caterpillar											
Stemming truck	15 m3	Ground Force	Stemming truck body (Groundforce)	NEFC	373,642	29,000	21,882	5,000	21,826	45,135	496,485
Standpipe	220 l/sec	Megacorp	MMP4, Mega Mobile Pump (MegaCorp)	NEFC	64,163	11,614	5,000	0	0	8,078	88,855
Other											
Lighting tower	3800 m2	Tower Light	VT-8m	Pilot Crushtec	34,245	5,000	2,500	0	0	8,767	50,512
Crane 25 t	25 t	Franna	MAC 25-4 SL	TBA	227,700	10,000	15,000	0	18,664	56,987	328,351
Crusher for road base and stemming	20-30 m3/hr	Pilot Crushtec		Pilot Crushtec	636,639	20,000	20,000	0	0	142,094	818,733
Ute Hilux – single cab		Toyota	Hilux Single Tray Back	TBA	31,007	2,000	500	0	500	7,142	41,149
Ute Hilux – twin cab		Toyota	Hilux Twin Cab Tray Back	TBA	30,504	2,000	500	0	500	7,036	40,540
Land Cruiser wagon		Toyota	troop carrier	TBA	54,444	2,000	500	0	500	12,063	69,507
Minibus 22-seater	15 Seat	Toyota	Coaster	TBA	53,084	5,000	1,000	0	1,000	12,618	72,702
Keto 150 l/s pump 150 m total head	150 l/s	Truflow	150/150 Vac - Prime	TBA	210,600	5,000	2,000	0	1,000	45,906	264,506

Note: 1. Costs adopted from information provided by Caterpillar for similar size machine or pro rata estimate of nearest size machine.

2. Cab chassis quoted only. Cost of appliance module estimated from information supplied by Caterpillar

5.9.2 Mining equipment schedule

Equipment requirements were estimated from the operating hours summarised in Table 5.34. An assessment was made of annual operating hours for the machines and applied on a quarterly basis to the machines. The operating hour estimate considered a range of operational and maintenance delay events:

- Weather delays of 15 days per year
- Scheduled service intervals: that are machine dependent but typically 8 hours for every 250 engine hours
- Breakdowns are estimated on a mean time between failure and mean time to repair basis. Typical provisions were 50 and 7 hours respectively for excavators and 60 and 6 hours for trucks
- Operational delays:
- Shift start and finish
- Travel
- Meal breaks
- Allowance for blast clearing and safety meetings.

The mining operations will run three 8-hour shifts per day.

The machine annual operating time used in the estimation of equipment numbers is given in Table 5.44.

Table 5.44 Capital equipment cost build up

Description	Operating hours per annum
Primary fleet	
Digger required 200 t	5,467
Digger required 120 t	5,467
Trucks required	5,963
Blasthole drills required	5,511
RC drills	5,511
Ancillary fleet	
Track dozer	5,243
Wheel dozer	5,243
Grader	5,520
Water cart	5,520
Batter digger	5,326
Rock breaker	5,326
Stemming truck	2,750
Fuel and lube truck	5,520
Minor equipment	
IT carrier with forks	5,500
Tyre handler	5,500
Backhoe	2,500
Skidsteer loader	2,500
Standpipe	5,500
Mobile workshop crane 25 t	5,500
Dewatering pumps	8,000

The equipment schedule was estimated on the basis of minimum integer number of machines required to achieve the estimated machine hour schedule in Table 5.34. An equipment tolerance factor of 0.1 number of machines was applied prior to rounding up to integer values. The equipment schedule is provided in Table 5.45.

Table 5.45 Mining equipment schedule

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Max.
Primary fleet																		
Excavator 200 t	no.	0	1	2	3	3	3	3	3	3	2	1	1	1	0	0	0	3
Excavator 120 t	no.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Trucks 90 t	no.	5	5	9	12	13	13	13	13	12	8	5	3	1	1	1	1	13
Blasthole drills	no.	1	1	1	1	1	2	2	2	2	2	1	1	1	0	0	0	2
RC drills	no.	1	1	2	2	2	4	4	4	4	3	2	1	1	0	0	0	4
Ancillary fleet																		
Track dozer	no.	1	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	2
Wheel dozer	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Grader	no.	1	1	1	2	2	2	2	2	2	1	1	1	1	1	1	1	2
Water cart	no.	1	1	2	2	2	2	2	2	2	1	1	1	1	1	1	1	2
Batter digger	no.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Rock breaker	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Stemming truck	no.	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	1
Lighting tower provision	no.	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
Fuel and lube truck	no.	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Minor equipment																		
IT carrier with forks	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Tyre handler	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Backhoe	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Skidsteer loader	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Standpipe	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Mobile workshop crane 25 t	no.	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Dewatering pumps	no.	1	1	1	1	1	2	2	2	2	3	3	3	3	0	0	0	3

Light vehicles																		
Single cab utes	no.	0	8	8	8	8	8	8	8	8	8	8	8	8	5	5	0	8
Twin cab utes	no.	1	5	5	5	5	5	5	5	5	5	5	5	5	1	1	0	5
Troop carrier	no.	2	5	5	5	5	5	5	5	5	5	5	5	5	3	3	0	5
Coaster bus	no.	0	2	2	2	3	3	3	3	3	2	1	1	1	1	1	0	3

5.9.3 Equipment capital schedule

A procurement schedule was developed based on increase in fleet requirements as the project ramped up as well as replacement of fleet to maintain reasonable serviceable life of fleet.

The replacement intervals were determined from a maximum average life of asset for each classification of the machine (Table 5.46). These maximum values were set at approximately 60% to 70% of the expected maximum life of an individual asset. For example the maximum average life for the fleet of trucks was set to 40,000 hours, 67% of the expected maximum life of 60,000 hours.

Table 5.46 Maximum average life of asset

Description	Maximum average life
Primary fleet	
Digger required 200 t	40,000
Digger required 120 t	30,000
Trucks required	40,000
Blasthole drills required	30,000
RC drills	30,000
Ancillary fleet	
Track dozer	40,000
Wheel dozer	30,000
Grader	40,000
Water cart	40,000
Batter digger	30,000
Rock breaker	30,000
Stemming truck	20,000
Lighting towers	40,000
Fuel and lube truck	40,000
Minor equipment	
IT carrier with forks	20,000
Tyre handler	20,000
Backhoe	20,000
Skidsteer loader	20,000
Standpipe	20,000
Mobile workshop crane 25 t	30,000
Dewatering pumps	20,000
Light vehicles	
Single cab utes	5,000
Twin cab utes	5,000

Troop carrier	5,000
Coaster bus	5,000

The equipment procurement schedule derived from these lives is given in Table 5.47. It was noted that there was estimated to be limited replacement equipment required for the project. This is largely due to the relatively short duration of peak output (i.e. material movement) from the pit, after which the demand on equipment falls and there will be multiple assets parked with reasonable serviceable life remaining.

The mining capital equipment schedule is given in Table 5.48.

Table 5.47 Mining equipment procurement schedule

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Primary fleet																		
Digger 200 t	no.	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	3
Digger 120 t	no.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Trucks	no.	5	-	4	3	1	-	-	-	-	-	-	-	-	1	-	-	14
Blasthole drills	no.	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	2
RC drills	no.	1	-	1	-	-	2	-	-	-	-	-	-	-	-	-	-	4
Ancillary fleet																		
Track dozer	no.	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Wheel dozer	no.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Grader	no.	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	2
Water cart	no.	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Batter digger	no.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Rock breaker	no.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Stemming truck	no.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Lighting tower provision	no.	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Fuel and lube truck	no.	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Minor equipment																		
IT carrier with forks	no.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Tyre handler	no.	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2
Backhoe	no.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Skidsteer loader	no.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Standpipe	no.	-	1	-	-	-	-	-	-	-	-	1	-	-	-	-	-	2
Mobile workshop crane 25 t	no.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1

Dewatering pumps	no.	1	-	-	-	-	1	-	-	-	1	-	-	1	-	-	-	4
Light vehicles																		
Single cab utes	no.	-	8	-	-	-	1	2	2	2	1	2	2	1	-	-	-	21
Twin cab utes	no.	1	4	-	-	-	-	-	-	-	1	-	1	-	-	-	-	7
Troop carrier	no.	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Coaster bus	no.	1	1	1	-	-	1	-	-	1	1	-	-	-	-	-	-	6

Table 5.48 Mining capital equipment schedule

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Primary fleet																		
Digger 200 t	$M	-	2.336	2.336	2.336	-	-	-	-	-	-	-	-	-	-	-	-	7.01
Digger 120 t	$M	1.075	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.075
Truck 90 t	$M	6.338	-	5.070	3.803	1.268	-	-	-	-	-	-	-	-	1.268	-	-	17.75
Blasthole drills	$M	0.869	-	-	-	-	0.869	-	-	-	-	-	-	-	-	-	-	1.74
RC drills	$M	1.595	-	1.595	-	-	3.189	-	-	-	-	-	-	-	-	-	-	6.38
First fills spare parts (all machines)	$M	0.559	1.118	0.559	-	-	-	-	-	-	-	-	-	-	-	-	-	2.24
Ancillary fleet																		
Track dozer	$M	0.805	-	0.805	-	-	-	-	-	-	-	-	-	-	-	-	-	1.61
Wheel dozer	$M	-	0.595	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.60
Grader	$M	0.494	-	-	0.494	-	-	-	-	-	-	-	-	-	-	-	-	0.99
Water cart	$M	0.721	-	0.721	-	-	-	-	-	-	-	-	-	-	-	-	-	1.44
Batter digger	$M	0.334	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.33
Rock breaker	$M	-	1.075	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.08
Stemming truck	$M	0.496	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.50
Lighting towers	$M	0.303	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.30
Fuel and lube truck	$M	0.974	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.97

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Minor equipment																		
IT carrier with forks	$M	-	0.414	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.41
Tyre handler	$M	-	0.502	-	-	-	-	-	-	-	-	0.502	-	-	-	-	-	1.00
Backhoe	$M	-	0.139	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.14
Skidsteer loader	$M	-	0.090	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.09
Standpipe	$M	-	0.089	-	-	-	-	-	-	-	-	0.089	-	-	-	-	-	0.18
Mobile workshop crane 25 t	$M	-	0.328	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.33
Dewatering pumps	$M	0.265	-	-	-	-	0.265	-	-	-	0.265	-	-	0.265	-	-	-	1.06
Discharge line 2 x 6" pipes	$M	0.050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
Roadbase and stemming crusher	$M	-	0.819	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.82

Description	Units	Y-2	Y-1	Y1	Y2	Y3	Y4	Y5	Y6	Y7	Y8	Y9	Y10	Y11	Y12	Y13	Y14	Total
Light vehicles																		
Single cab utes	$M	-	0.329	-	-	-	0.041	0.082	0.082	0.082	0.041	0.082	0.082	0.041	-	-	-	0.86
Twin cab utes	$M	0.041	0.162	-	-	-	-	-	-	-	0.041	-	0.041	-	-	-	-	0.28
Land Cruiser	$M	0.139	0.209	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.35
Coaster bus	$M	0.073	0.073	0.073	-	-	0.073	-	-	0.073	0.073	-	-	-	-	-	-	0.44
Flatbed trucks for workshop	$M	-	0.070	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.07
Miscellaneous																		
Magazine installation	$M	-	0.623	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.62
Workshop tooling	$M	0.050	0.100	0.050	-	-	-	-	-	-	-	-	-	-	-	-	-	0.20
Survey equipment	$M	0.100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.10
Surpac	$M	0.025	0.050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.08
Minesched	$M	-	0.050	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
Other software	$M	-	0.010	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
Seacontainers for storage	$M	0.003	0.006	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.01
Miscellaneous items	$M	0.013	0.025	0.013	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05
TOTAL	**$M**	**15.571**	**8.586**	**11.220**	**6.632**	**1.268**	**4.436**	**0.082**	**0.082**	**0.155**	**0.419**	**0.673**	**0.123**	**0.306**	**1.268**	**-**	**-**	**50.82**

5.9.4 Mining costs not estimated

5.9.4.1 Mining activities related infrastructure

The mining operations at Tulu will require certain fixed infrastructure such as buildings and workshops. The costs for these facilities are covered in the SENET estimate for infrastructure.
Following is a description of the fixed infrastructure required for the mining operations.

5.9.4.1.1 Explosives magazine

Two separate magazines will be used for the storage of accessories and detonators, and packaged explosives. Lightning protection will be provided for the magazine storage buildings that may be high quality second-hand sea containers that timber lined to provide an insulated interior for explosives storage. The storage buildings will be fenced by an appropriate security fence and there will be a 2 m high safety bund for the explosion containment in the event of an uncontrolled explosive initiation.
The security of the explosives magazine will be managed through the use of security guards and a gatehouse is also included for the guards and boom-gate will regulate the passage of the explosive transport vehicles. There will be a register required for all explosive stocks and dispatches to and from the magazine.

5.9.4.1.2 Bulk explosives plant

Bulk explosives will be delivered and mixed to provide the bulk blasting products for the mobile manufacturing units. This facility will be secured by fencing and provision is made for security guards. Construction of the hardstand and fencing is included in the capital estimate for mining. The cost of the emulsion manufacturing plant is included in the operating costs and is charged by the explosive supplier on a monthly basis.

5.9.4.1.3 Light vehicle workshop

A light vehicle workshop with two service bays has been included in the cost estimate. The light vehicle bay will occupy one of the repair bays in the main workshop and will service all light vehicles for the site. Costs for this facility were included in the SENET estimate for infrastructure.

5.9.4.1.4 Diesel and unleaded fuel storage

A bulk diesel storage facility is included in the SENET infrastructure costs for the project. The bulk storage facility will comprise 8 numbers of 50,000 l tanks stored below ground beneath a concrete fuelling apron.
A bund with a lined area and fuel bowsers and any security arrangements would all need to be considered in this feasibility study cost models.

5.9.4.1.5 Diesel dispatch

A secure diesel dispatch facility was considered with card swipe fuel dispatch through bowsers. The dispatch area is on a concrete hardstand with provision for spillage mitigation.

5.9.4.1.6 Used oil and grease storage

Tanks and vessels will be provided in a lined and bunded area for the dispatch of used fuels and oils and grease.

5.9.4.1.7 Refuse disposal

All refuse waste will be recycled or disposed of in landfill. Recycling bins and a rubbish tip will need to be established.

5.9.4.1.8 Heavy mobile plant tyre fitting area

A heavy mobile equipment ("HME") tyre-fitting area with necessary tyre changing and handling equipment is costed for the project and is included within the main structure of the HME workshop.

5.9.4.1.9 Tyre yard

All used tyres will be removed from site. A HME tyre storage and dispatch yard will be available adjacent to the HME tyre-fitting area.

5.9.4.1.10 Heavy mobile equipment workshop

A HME workshop will be constructed to the south of the process plant and adjacent to the mining and administration building. The facility will be constructed as an enclosed facility with a concrete hardstand. The workshop will include four maintenance bays (one for tracked vehicles) and an outdoor wash bay. A ready area of 150 m by 100 m will be constructed around the heavy vehicle workshop to allow for pre-start checks and minor maintenance tasks to be completed in the open air. No provision is made for a gantry crane however a 25 t mobile crane was included for lifting large components.

Maintenance planning offices and an administration office, document store and ablutions are all included in the maintenance facility.

5.9.4.1.11 HME store

A HME tooling and spares store will be included adjacent to the HME workshop.

5.9.4.1.12 HME and office services

All electrical power, potable water and compressed air requirements are considered for the prefeasibility stage. All offices will be air-conditioned and a bio system is considered for sewerage disposal using non-potable water.

5.9.4.1.13 Mining offices

The following offices will be required as part of the mining operations and will be covered in the infrastructure costs compiled by SENET:

- Short-term planning
- Ablutions
- Showers
- Mining administration offices

- Mining engineering offices
- Geology offices
- General meeting room
- Lunch room.

5.9.4.1.14 Shift change area

The shift change area will include the following which will be covered in the infrastructure costs compiled by SENET:

- Ablutions
- Showers
- Production foremen's offices
- Breeze-way for shift change and prestart/personnel toolbox discussions.

5.9.4.1.15 Mining haul roads

All development and maintenance costs for mining haul roads and roads to mining infrastructure facilities are included in the mining operating costs.

5.9.4.1.16 Water storage for dust suppression and pit dewatering

The raw water dam will provide a source of water for dust suppression and an discharge point for water pumped out of the pit. A standpipe will be located at the raw water dam where the water trucks can refill during dry periods.

5.9.4.1.17 Drainage between south dump and pit crest

Snowden also identified a water trap that resulted from a basin between the constructed south dump and the pit crest. Snowden considered that either an agricultural drain to point beyond the toe of the south dump, or an underground pipe to decant this basin and this will be implemented to drain the area in the event of heavy rainfall.

5.10 MINING OPERATIONS

5.10.1 Personnel

Large scale commercial mining in Ethiopia is a relatively new industry despite the knowledge and wealth of the country's resources. Ethiopia has one large scale gold mine owned by a private company, Midroc and a medium size open pit tantalum mine owned by a state enterprise, EMDSC. Together the two mines employ in the region of 1,800 personnel.

A workforce availability report (Meyer Hoskings & Associates, 2015) determined that a pool of skilled, experienced and educated mine workers in Ethiopia exists but may be limited. There is a small pool of educated, trained and experienced minerals industry employees and within this pool many of the individuals may not have the relevant qualification or years of experience to fill particular roles within KEFI by commissioning of the Tulu Kapi project. As such it may be necessary for KME to source appropriately skilled and experienced personnel externally from the country for at least the first few years from commissioning to steady state operations so as to allow for the appropriate transposition of skills through training and mentorship to Ethiopian nationals.

Where possible, local labour will be used to fill positions with training regimes configured to raise productivity level of skilled and semi-skilled personnel to achieve higher output.

Expat or third country national labour will be used to fill positions in the short term and where longer term positions are unable to be filled by locals. Senior positions will be staffed with expatriate labour from countries such as Australia, Canada or USA and remuneration was included to facilitate attracting appropriate personnel to the project.

Training of operators and maintenance personnel will be coordinated through the OEM or local vendor representatives.

5.10.2 Grade control

The grade control design was supplied by KEFI and costed by MACE. RC holes will be incorporated into the drill and blast pattern and set out using survey. Holes will be numbered consecutively with a naming sequence reflecting their general pit location, bench number and sequential identifier. Holes will be sampled at 1.0 m intervals. The RC samples will be collected after passing the cuttings through a cone-type splitter. Bags will be pre-numbered with a different colour and letter prefix for samples and duplicates. Standard or blank samples will be inserted in the sample sequence prior to fire assay. Control samples such as standards and/or blanks will be inserted on a basis of one per 20 m RC hole. Duplicates samples will be taken at a rate of one per hole (5%).

Each RC hole will be logged to capture weathering, sulphide %, rock type, groundwater, and sample sequence as an assay file. A palmtop computer with data logging software will be used when logging samples. The data will be downloaded on a daily basis. In addition, all samples will be weighed to ensure proper operation and performance of the cone splitter. This data will also be recorded.

At the completion of each GC program, results will be uploaded into the geological database and used to create a grade control model for mine planning purposes. A recognised geological consultant will be used to periodically peer review the grade control estimation process.

When mining in and around the narrow ore zone, blasts will be made as large as possible and will aim to locate zones of mineralisation well inside the blast to minimise movement and edge dilution. Alternatively, blast monitoring practices such as using blast markers or more advanced techniques will be used to determine any vectoring of the ore zone, to measure and ensure minimal ore movement. Controlled blasting techniques will be required where ore zones present at the edge of the pit face.

Experienced geological personnel will supervise the excavation of ore so that correct methods of marking out, digging directions and angles are observed. They will ensure that mark-ups are made as simple as possible to minimise dilution and reduce survey and grade control interruptions to the excavation process.

5.10.3 Drill and blast

Drill and blast parameters are described in Section 5.8. The blast parameters were determined by specialist consultants Itasca Pty Ltd. using industry recognised Kuzram fragmentation prediction algorithms. The fragmentation modelling considered the use of emulsion rather than ANFO in order to reduce heave energy and increase fragmentation through higher velocity of detonation. This approach was taken to avoid differential displacement along the ore zones which would otherwise increase ore loss and dilution.

Ore blasting parameters were designed to achieve fragmentation distribution with 98% passing 600 mm, being the aperture of the ROM bin grizzly. The standard hole size modelled was 115 mm diameter on a 7.5 m bench and allowed an additional 10% for sub-drill for a total hole depth of 8.25 m. Stemming heights allowed for a minimum of 20 borehole diameters and assumed the use of crushed aggregate to minimise the risk of stemming ejection and energy loss during the blast.

Fragmentation modelling was carried out using Syenite parameters only as this represented the predominant rock unit encountered in the pit. In addition, the diorite parameters and therefore blasting parameters are expected to be similar to that of the Syenite.

Key rock parameters determined in geotechnical studies were used in the fragmentation modelling as a median (P_{50}) average. Blast parameters were also estimated for a P_{20} and P_{80} ranges. The key parameters are given in Table 5.49.

Table 5.49 Fragmentation analysis parameters based on Syenite

Description	Units	P_{50}	P_{20}	P_{80}
Hole diameter	mm	115	115	115
Youngs modulus	Gpa	60	50	70
UCS	Mpa	120	96	144
Mean in-situ block size	m	0.30	0.17	0.54
Bench height	m	7.5	7.5	7.5
Burden	m	4.2	4.7	3.5
Spacing	m	4.8	5.4	4.0
Powder factor	kg/bcm	0.49	0.39	0.71

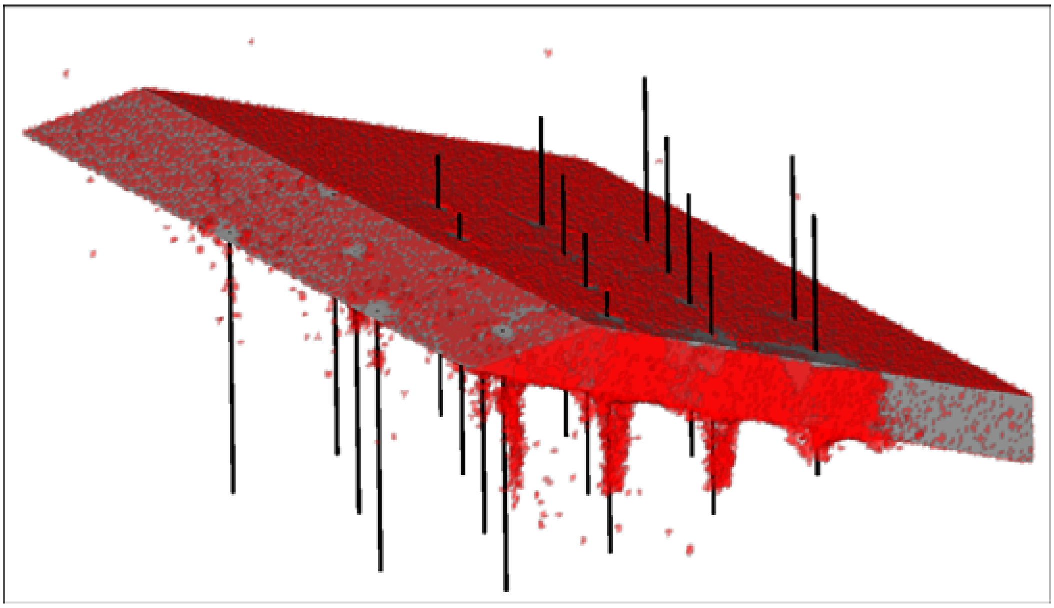
For the purposes of the study, the P_{80} parameters in Table 5.50 were used for productivity and cost estimation.

A blast movement prediction analysis was also carried out using the Itasca hybrid-stress blasting model ("HSBM") referred to as Blo-Up. Blo-Up is a three-component coupled model of rock blasting. The three components include the following:

- A continuum geomechanics model for the early-time detonation and near-field crushing
- A brittle discrete element model for stress wave propagation, fracturing and burden movement
- A gas product model for burden acceleration by gas expansion, fracture flow and atmospheric venting.

The P_{80} blast parameters were modelled for a variety of blasting directions. The model assumed the free face of the blast would be choked by the muck pile in front of the blast. A typical lens width of 2 m was modelled. The results of the analysis is shown in Figure 5.60 and indicate that very differential movement of the red blocks in relation to the grey pre-blast position is expected with the proposed blasting method. Some ore loss into the borehole void will happen but this is not expected to be significant and proposed dilution and loss factors were considered adequate to cover this effect.

Figure 5.60 Results for blast movement analysis using Blo-Up



5.10.4 Load and haul

A conventional mining cycle is envisaged using excavators loading of heavy earth moving trucks.

5.10.4.1 Selective ore excavation cycle

Within the mining cycle there a specific requirement for excavator cleaning and re-handling of waste material that is necessary to ensure mining selectivity. It is envisaged that mining will progress across the bench from west to east when possible to avoid collapsing the ore material into the waste, as would occur if mined from east to west. The selective mining process contains seven steps as:

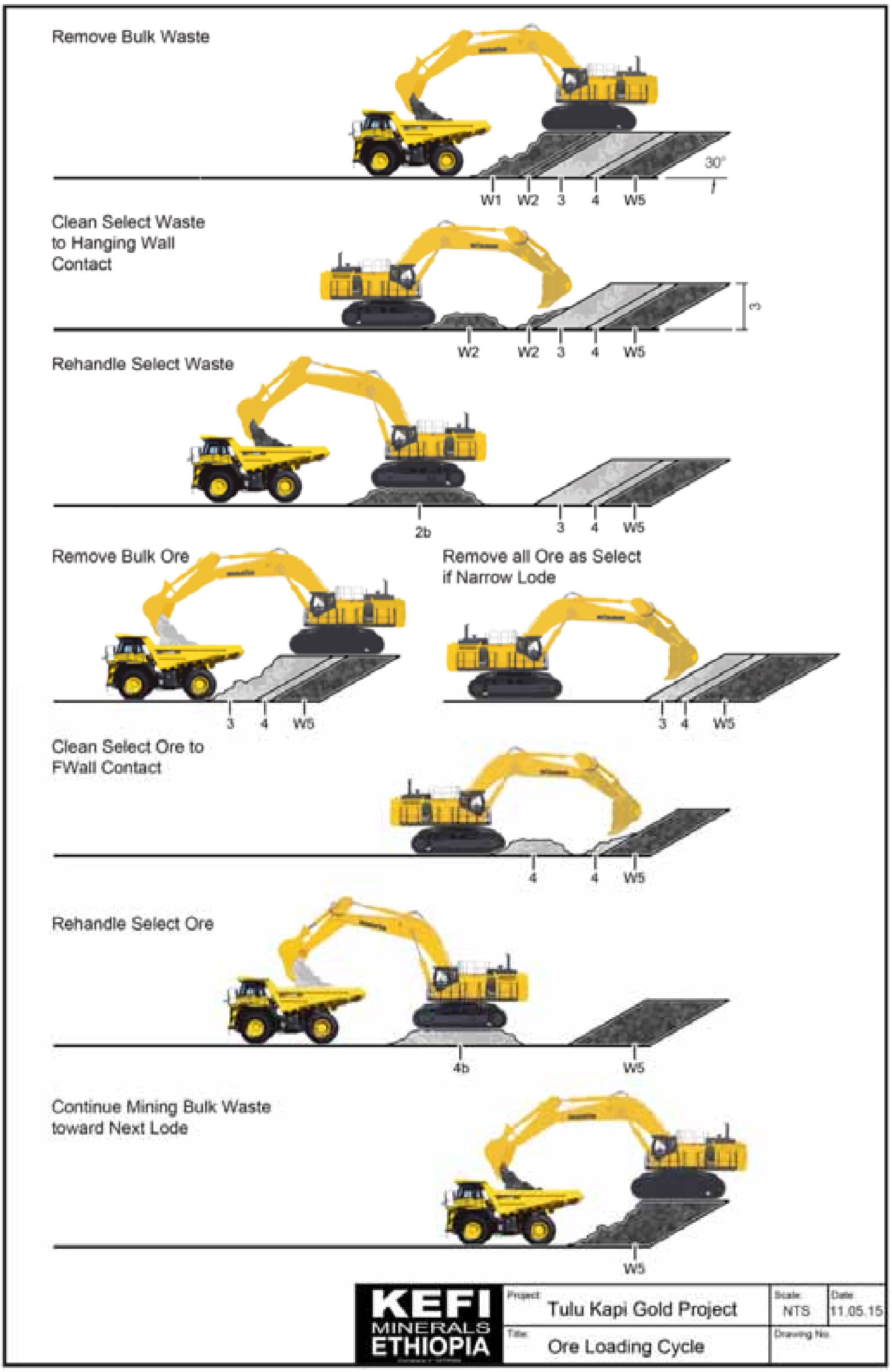
- Bulk waste removal
- Cleaning waste from the hangingwall contact
- Re-handling of selective waste
- Removal of bulk ore
- Cleaning of selective ore to the footwall contact
- Re-handling of select ore
- Continue mining the waste material.

The cycle utilises more productive top loading of trucks 3 m above the bench where the trucks traverse, however the excavator needs to be on the same level as the trucks when:

- Removing waste less than 1 m thick from the ore on the western lode contact
- Moving final ore from waste on the eastern lode contact when the ore is less than 1 m thick
- When bottom loading of trucks that may be necessary when handling the windrows created from the above two activities.

For ore lodes greater than 2 m wide, the excavator will be able to resume top loading activities. The selective mining cycle is shown graphically in Figure 5.61.

Figure 5.61 Tulu Kapi selective mining cycle



5.10.5 Clearing and grubbing

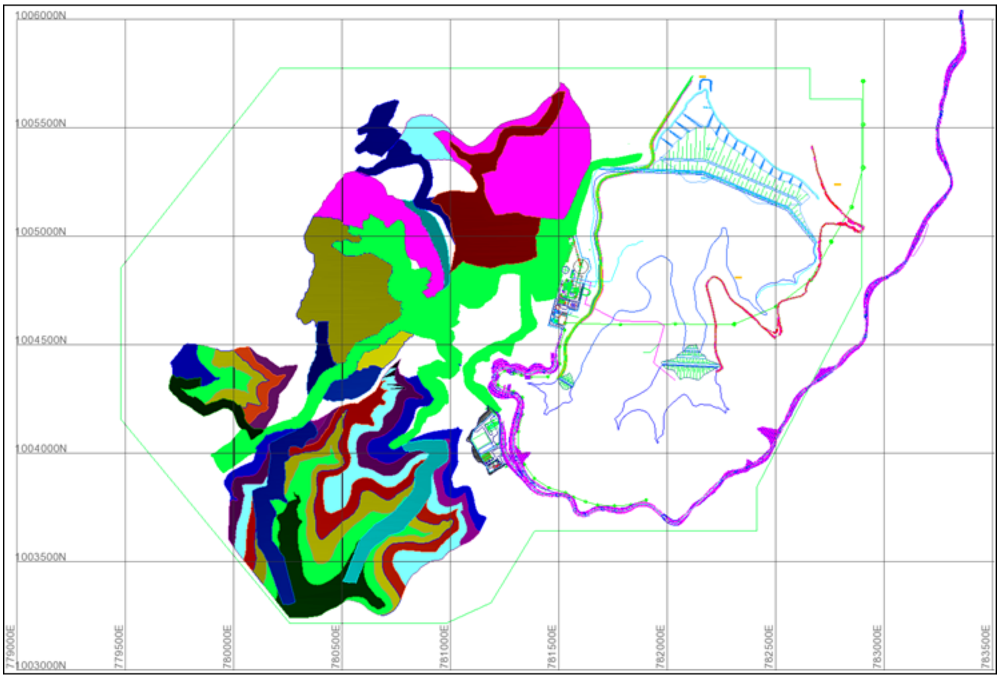
Clearing and grubbing will be required ahead of pit and waste dump development. Topsoil will be stored and softer materials pushed out of the foundation of the dumps. The depth of stripping and associated grubbing activities will be on average 0.3 m deep. The amount of clearing and grubbing is summarised in Table 5.50.

Table 5.50 Clearing areas

Location	Area (hectares)	Days to complete
Construction	56.92	98.87
Pit Stage 1	21.42	38.75
Pit Stage 2	10.88	20.14
Pit Stage 3a	4.61	9.99
Pit Stage 3b	2.17	4.71
Pit Stage 4	3.34	7.25
Pit Stage 4 dump	7.36	15.95
ROM Pad Stage 2 (Stage 1 is in construction period)	21.78	39.87
Southern dump bottom access road 1	7.18	13.96
Southern dump bottom access road 2	7.88	15.13
Southern dump to 1670 Stage 1	9.10	17.16
Southern dump to 1670 Stage 2	11.17	22.51
Southern dump to 1670 Stage 3	11.86	23.77
Southern dump to 1670 Stage 4	13.27	26.44
Southern dump to 1670 Stage 5	13.63	27.94
Southern dump to 1670 Stage 6	8.41	18.19
Southern dump to 1670 Stage 7	8.75	18.96
Western dump bottom access road	3.13	6.79
Western dump Stage 1	2.26	4.89
Western dump Stage 2	3.24	7.03
Western dump Stage 3	3.10	6.72
Western dump Stage 4	2.36	5.12
Western dump Stage 5	2.42	5.24
Total	**236.26**	**455.37**

The clearing areas are shown in Figure 5.62 that are coloured by quarter.

Figure 5.62 Tulu Kapi mine clearing areas



5.10.6 Pit dewatering and drainage

5.10.6.1 Seepage generation from mining

Pits will be developed in a series of stages. The groundwater table in the pit areas is generally between 30 m and 50 m below ground level (WAI, 2012). Groundwater modelling suggests that total mean annual seepage rates increase from 10 l/sec to 46 l/sec over LOM.

Pit terraces will intersect the groundwater table and allow dewatering of the overlying terrace(s) from deeper stages in the pit. The groundwater seepage will be conveyed to the pit storm water runoff collection ponds and provide a source for mitigation of hydrological impacts (any reduction of spring and base-flow in streams caused by mining).

The quality of the seepage water is expected to be generally good and it is envisaged that water collecting in the pit will have a sufficiently short residence time for water quality to be unaffected by acidification associated with sulphide minerals. It is anticipated that a proportion of the pit dewatering volumes will be recycled in the mine process water supply. Where mine water volumes exceed demand requirements, effective disposal of mine water will be necessary. If appropriately managed, discharge to the surface water environment is the most cost-effective disposal option.

5.10.6.2 In-pit storm runoff management

The system of storm-water management comprises diversion channels and ditches for gravity conveyance of storm water to pit floor sumps and subsequent pumping to the pit crests. Gravity discharge of de-silted water is then possible to existing streams. Stripping of the ridgeline for development of mine terraces in early months of project development will increase the volume of runoff. Diversion channels and ditches on mine terraces will be used to contain and direct storm-water to the sumps and prevent direct discharge to the environment.

Priority will be given to using sump water for dust suppression where and when possible but demand will typically be low during the wet season when sump water volumes are highest. During these periods, sump discharges will be directed via gravity drainage to sediment management systems including ground infiltration systems and sediment retention ponds.

Erosion and sediment control will be managed through rapid rehabilitation of disturbed areas and, where necessary, through the construction of small scale sediment control structures and sumps in downstream areas. Discharge from these structures and sumps will either be directed to the streams (providing discharge criteria can be met) or will be applied to the land.

5.10.6.3 Waste rock dumps and stockpiles

All runoff from the main (permanent) waste rock dump, mineralised rock dumps, low grade stockpile and high grade stockpile (collectively known as "WRDs") will be routed via appropriately sized collection channels and ditches to erosion and sediment control structures before subsequent discharge to existing streams.

The rocks to be stored in the proposed stockpiles have relatively coarse particle size distributions ("PSDs") and will produce relatively low quantities of Total Suspended Solids ("TSS") in storm runoff. Consequently, residual control of TSS concentrations in runoff from these features can be readily achieved by developing and operating very modest pond retention systems.

The proposed main WRD and mineralised WRDs are proposed to host rocks with relatively finer PSDs and can potentially produce relatively high quantities of TSS. Therefore feasible mitigation measures will be undertaken to minimise the generation of TSS from within these features at source.

To maintain the storage capacity of the sediment ponds and ensure that they are effective throughout the year, all residual water and sediment should be removed and deposited in the TSF at the start of the dry season.

5.10.6.4 Rainfall and groundwater estimates

Rainfall records were sourced from the Golder Associates work reported by in WAI (2012). A summary of rainfall in and around Tulu Kapi is provided in Table 5.51.

Table 5.51 Rainfall records

Month	One year 2012 Tulu Kapi site (mm)	2010 to 2012 three sites (Aira, Gimbi, Alghe) (mm)
January	0	11
February	0	11
March	0	32
April	0	72
May	0	206
June	340	318
July	350	313
August	168	325
September	298	326
October	151	141
November	35	34
December	0	15
Total	**1,342**	**1,804**

Snowden assessed the accumulation of rainfall corresponding to various stages of the pit development in Table 5.52.

Table 5.52 Stage accumulation of rainfall

Pit stage	Catchment (ha)	Catchment (m^2)	Cumulative stage catchment (m^2)	Yearly average volume (m^3)	Litres per second	Cumulative stage data	
						Maximum monthly volume (m^3)	Litres per second
Pit Stage 1	21.4	214,202	214,202	342,723	10.9	89,965	34.2
Pit Stage 2	10.9	108,830	323,032	516,851	16.4	135,673	51.6
Pit Stage 3a	4.6	46,098	369,130	590,608	18.7	155,035	59.0
Pit Stage 3b	2.2	21,747	390,877	625,403	19.8	164,168	62.5
Pit Stage 4	3.3	33,443	424,319	678,911	21.5	178,214	67.8
Subtotal		**424,319**					

The pit groundwater seepage from the 2012 WAI report was used, and the groundwater accumulation in the pit was expected to be as summarised in Table 5.53.

Table 5.53 Groundwater seepage

Years 1 to 3 (l/s)	Years 4 to 6 (l/s)	Year 7 to LOM (l/s)
10	16	46

Snowden then assessed the yearly requirements for pumping total water inflows from rainfall and seepage as summarised in Table 5.54. The pump head per year by stage is also provided.

Table 5.54 Tulu Kapi total requirements for pumping total water inflows

		Year											
		-1	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Groundwater	l/s		10	10	10	16	16	16	46	46	46	46	46
Rainfall	l/s		34.2	51.6	51.6	51.6	59.0	59.0	62.5	62.5	62.5	67.8	67.8
Total			**44.2**	**61.6**	**61.6**	**67.6**	**75.0**	**75.0**	**108.5**	**108.5**	**108.5**	**113.8**	**113.8**
Depth to crest	st1 (m)		60	105	150	195							
	st2 (m)			22.5	52.5	90	135	172.5	202.5	247.5	247.5	247.5	247.5
	st3 (m)						52.5	90	135	180	225	277.5	
												22.5	37.5

5.10.7 Continuous improvement

The following items are indemnified as mining continuous improvement for the project:

- Variations in grade control will be necessary in the early months of the operation and if variability is observed in the nature of the ore lenses. Adjusted grade control will ensure maximum delineation of orebodies and will minimise dilution.
- The deployment of a real-time mining monitoring system (dispatch) that will enable production tracking and result in reduced misallocations of ore to areas other than the ROM and of waste to areas other than the dump.
- Reconciliation practises to validate the:
    - Mining dilution
    - Mill recoveries
    - Robustness of the resource block model.
    - Monitoring density and adjustment to models.
- Inclusion of a truck payload measurement system to enable accurate filling of mine dump trucks and avoid overloading which can lead to premature component failure.
- Multi-skilling workforce. Each vehicle was fully manned with additional provision for absenteeism. Multi-skilling the operators to move between machines will reduce the labour burden of the project.
- Blast monitoring and reconciliation to improve fragmentation prediction, reduce movement, dilution and ore loss. This would include the use of blast movement indicators, vibration monitoring and noise overpressure measurement. All blasts should be recorded on digital video and catalogued for future reference. Monitoring of excavator production rates can also provide useful information on blast performance.
- If "carry back" clay sticks to the truck tray after dumping, optimisation of truck tray designs may be required to reduce material stuck in trays. This allows an increase in payload and thereby improves efficiency. The tray optimisation may only be relevant to trucks working in clay areas, considering that most of the deposit is granitic Syenite.
- Investigate beneficiation of low grade material. Some materials demonstrate a natural beneficiation characteristic through the crushing and screening process. Beneficiation would reduce the amount of gangue material delivered to the grinding and leaching circuit, thereby reducing the cost per tonnes and potentially allowing a reduction in cut-off grade if realised.

- Introduction of Enterprise Resource Planning software such as Pronto or Oracle to enable centralised recording and reporting of costs and inventory controls.

5.11 ORE RESERVE STATEMENT

The gold Mineral Resources and Ore Reserves for KEFI's Tulu Kapi gold deposit are estimated by Snowden. Snowden identified an updated mining inventory based on the updated Mineral Resource estimate from February 2015. Snowden's Ore Reserves at April 2015 are estimated using a 0.5 g/t Au cut-off as provided in Table 5.55.

Table 5.55 April 2015 Tulu Kapi Ore Reserve estimate reported above a 0.5 g/t Au cut-off

JORC (2012) Reserve category	Cut-off (g/t Au)	Tonnes (Mt)	Au (g/t)	Ounces (Moz)
Probable – High grade	0.90	12.0	2.52	0.98
Probable – Low grade	0.50 to 0.90	3.3	0.73	0.08
Total		**15.4**	**2.12**	**1.05**

Note: Mineral Resources are inclusive of Ore Reserves. Numbers are reported to three significant figures. Small discrepancies may occur due to the effects of rounding.

While exercising all reasonable due diligence in checking and confirming the data validity, Snowden has relied largely on the data as supplied by KEFI for the 2015 Tulu Kapi Mineral Resource estimate to estimate and classify the Ore Reserve. As such Snowden accepts responsibility for the geotechnical design configuration, pit design, production schedule, direct mining costs and the reserve estimate and classification while KEFI has assumed responsibility for the accuracy and quality of the metallurgical data, capital estimates and non-mining related operating costs.

The key Modifying Factors used to estimate the Ore Reserve are based on the experience of Snowden and KEFI employees in this type of deposit and style of mineralisation. Table 5.56 summarises material aspects of the April 2015 Ore Reserve estimate in accordance with the reporting requirements of the JORC Code (2012 edition) as "Table 1, Section 4, Estimation and Reporting of Ore Reserves".

The information in this report that relates to Tulu Kapi Ore Reserves is based on information reviewed or work undertaken by Mr Frank Blanchfield, FAusIMM and a full-time employee of Snowden. Mr Blanchfield has sufficient experience relevant to the style of mineralisation and type of deposit under consideration and to the preparation of mining studies to qualify as a competent person as defined by the JORC Code (2012 edition).

The scientific and technical information in this report that relates to process metallurgy is based on information reviewed by Mr Sergio Di Giovanni, who is a full-time employee (Project Development Manager) of KEFI. Mr Di Giovanni is a member of the Australasian Institute of Mining and Metallurgy. Mr Di Giovanni has sufficient experience relevant to the style of mineralisation and type of deposit under consideration and to the activity being undertaken to qualify as a Competent Person as defined by the JORC Code (2012 edition).

Mr Di Giovanni consents to the inclusion in the report of the matters related to the metallurgy, in the form and context in which it appears. Mr Blanchfield consents to the inclusion in this report of the matters based on information provided by them and in the form and context in which it appears.

Table 5.56 Competent Person's assessment of Ore Reserve estimation for Tulu Kapi deposit (Table 1 - Section 4 of the JORC Code)

Item	Comment
Mineral Resource for conversion to Ore Reserve	Snowden prepared the updated Tulu Kapi Mineral Resource estimate in February 2015. The relevant part of the Mineral Resource estimate is provided below. No planned dilution was applied to these estimates. Mineral Resources are inclusive of Ore Reserves. **JORC (2012) Mineral Resource category** / **Reporting elevation** / **Cut-off (g/t Au)** / **Tonnes (Mt)** / **Au (g/t)** / **Ounces (M)**: Indicated / above 1,400 RL / 0.45 / 17.7 / 2.49 / 1.42
Site visits	No site visit was undertaken by Mr Blanchfield who is one of the Competent Persons for the Ore Reserve estimate, however Mr Di Giovanni, who is the Competent Person for metallurgy has visited the Tulu Kapi project site as well as Mr John Graindorge, a Snowden resource geologist who visited the Tulu Kapi project site for the purposes of Mineral Resource estimation in July 2014. They have reviewed data and photos with Mr Blanchfield to his satisfaction.
Study status	Previous studies: • A definitive feasibility study ("DFS") was completed by the previous owner, Nyota, in 2012 • Work was completed by Snowden in August 2014 to update Ore Reserves using an updated Mineral Resource (by Snowden). Snowden considers that most of the 2014 work completed for Ore Reserves estimation was of a prefeasibility-level accuracy however there were some omissions (that did not affect the materiality of the reserve estimate) that prevented Snowden determining the 2014 reporting as a prefeasibility study ("PFS") and there was no published prefeasibility studies for KEFI's Tulu Kapi project. Current studies: • The Tulu Kapi feasibility study ("FS") is at an advanced stage. Snowden has completed most of the mining studies consistent with the accuracy required for this type of study, however costings are currently at a prefeasibility level but considered still appropriate for the current April 2015 Ore Reserve. These costings are expected to be validated by fully detailed costs at the conclusion of the FS.
Cut-off parameters	An elevated cut-off grade of 0.9 g/t Au is used for the first 10 years of the project production schedule. Ore at a cut-off of between 0.50 g/t Au and 0.9 g/t Au was stockpiled and then processed in the final three years of the project resulting in a project life of 13 years. The marginal cut-off grade was estimated to be 0.47 g/t Au based on the economic inputs and Modifying Factors outlined in this table. It should be noted that the August 2014 Ore Reserve for Tulu Kapi only reported ore at an elevated cut-off of greater than 0.8 g/t and no low grade ore was included in the 2014 Ore Reserve.
Mining factors and assumptions	To identify the Tulu Kapi Ore Reserve, a process of Whittle pit optimisation, staged pit design production scheduling and mine cost modelling was undertaken by Snowden. The mining method modelled is conventional open pit drill and blast, load and haul on a 7.5 m high blasting bench, reflecting a semi-selective mining approach using 120 t class backhoe

Item	Comment
	configured excavators. No special infrastructure requirements will be required for this mining method. Three months of overburden pre-stripping will be required where a small amount of ore is to be stockpiled. Planned dilution was applied through modelling a 500 mm vertical block dilution. This reduced the feed ounces by approximately 5% and increased the ore tonnage processed by 9%. An unplanned ore loss of 5% was also applied to the ore inventory. Less than 80 kt or 0.6% of the Mineral Resource inside the pit is classified as Inferred. This Inferred resource was considered as diluting grade, and only influenced the grade adjacent in the Indicated Mineral Resource blocks. It is therefore not incorporated into the Ore Reserve.
Metallurgical factors and assumptions	The mineralisation modelled and metallurgical testwork available indicate that conventional CIL extraction can be used, to produce gold as doré. The gold is free milling and all the unit processes included in the plant design are standard and common to many current gold operations. The testwork program included: • Comminution testwork • Flotation testwork • Cyanidation testwork • Oxygen uptake • Gravity recoverable gold testwork • Thickening testwork • Cyanide detoxification. Variability testwork was conducted on samples from different lithologies and different mineralised zones. Samples were selected mainly to define the differences in ore hardness (or grindability) and gold recovery. Samples were taken from 11 geographically diverse oxide mineralised zones for grindability and extraction testwork, 16 samples from spatially diverse fresh mineralised zones for extraction testwork and five samples from spatially diverse fresh mineralised zones for both comminution variability and extraction testwork. There are no deleterious metals identified. No bulk sample or pilot scale test work was justified or completed. The metallurgical factors were developed by SENET and reviewed by Snowden. Metallurgical recoveries were applied to the Snowden optimisation and Snowden production schedule and KEFI's financial model. The algorithms estimate lower recovery at lower ore grade as used for this Ore Reserve estimate include the following: • Oxide ore: 100 x 0.986*((DilAu-(0.0465*DilAu+0.0294))/DilAu), ranging from 88.2% to 96.0% LOM, at an average of 95.6% • Fresh ore: 100 x 0.986*((DilAu-(0.053*DilAu+0.0193))/DilAu), ranging from 85.3% to 94.7% LOM, at an average of 94.0% • Fresh hard ore: 100 x 0.986*((DilAu-(0.0916*DilAu+0.0056))/DilAu), ranging from 69.7% to 95.6% LOM, at an average of 89.6% • The overall LOM recovery was estimated to be 91.5%.
Environmental	Rock characterisation studies were completed by Golders. No acid rock drainage ("ARD"), or elevated geothermal temperatures were identified. The Mining Licence was approved and issued in April 2015. The Mining Licence allows provision for onsite tailings impoundment and waste rock land forms.

<table>
<tr><th>Item</th><th>Comment</th></tr>
<tr><td></td><td>Final landform waste dumps will be modelled for the DFS.</td></tr>
<tr><td>Infrastructure</td><td>Detailed discussions were recently held with local power authority (EEPCo) regarding connection to the national electricity grid. Other than utility charges, no other significant operating costs arise for grid connected electrical energy usage. Published tariff data for industrial consumers taking supply at high voltage is used as the basis for the operating cost under this supply option.

Local labour will be sourced from surrounding communities and a camp will be constructed for 250 persons to house expatriate and non-local personnel.</td></tr>
<tr><td>Cost and revenue factors</td><td>Process costs were developed from first principles by SENET, for a new process plant.

Process costs included the following:

<table>
<tr><th>Item</th><th>US$/t ore</th></tr>
<tr><td>LOM oxide ore processing costs</td><td>9.41</td></tr>
<tr><td>LOM fresh ore processing costs</td><td>7.09</td></tr>
<tr><td>LOM fresh hard ore processing costs</td><td>10.42</td></tr>
<tr><td>LOM average process operating costs</td><td>8.17</td></tr>
<tr><td>Site G&A</td><td>5.38</td></tr>
<tr><td>Total</td><td>13.55</td></tr>
</table>

Prefeasibility mining costs were developed from first principles by Snowden in 2014 for an all up mining cost of US$2.74 per tonne. This cost was scaled up to US$3.00 per tonne to allow for the costs of semi-selective mining. In June 2015, MACE has confirmed a cost at US$3.06 per tonne
Mining capital costs were estimated to be US$23.3M including mobile equipment and fixed mine infrastructure. MACE later updated the mining capital costs to :
Capital Development US$15.59M
Capital Equipment US$50.82M.
Other capital costs include the following:

Process capital costs are US$58.3M
Tailings infrastructure costs US$7.5M
Other infrastructure costs (TSF, roads, power, camp) of US$21.7M
Indirect costs (EPCM and insurance) US$12.6M
Owners costs of US$8.8M
Sustaining costs of US$43.9M (including Snowden sustaining capital of US$12M)
Working capital of US$5.9M

Closure costs were included and estimated to be $8.25M
Refining costs of US$5.77 per ounce (US$8.88 per ounce inclusive of transport) were included
A royalty of 7% were applied to net revenue from sales of gold produced
All costs were supplied in US$.
</td></tr>
<tr><td>Revenue factors</td><td>A gold price was supplied by KEFI at US$1,250 per ounce. This was applied real and as a flat forward price in the financial model.</td></tr>
</table>

Item	Comment
Market assessment	In determining the revenue parameters, KEFI conducted comprehensive market studies including discussion with likely refiners. A comprehensive marketing study was also completed as part of the Nyota 2012 DFS concluding the refining of the doré. Gold is free trading.
Economic	A discount rate of 8% was applied in the KEFI financial model. A financial sensitivity study was undertaken evaluating capital expenditure, operating costs and gold price. The project was seen to be most sensitive to changes in gold price, with a 20% reduction in price resulting in a breakeven NPV position, whilst a 20% increase in price approximately doubled the NPV. Key project metrics*** (after tax) from the KEFI cash flow model include the following: All in cash cost including royalty, excluding salvage costs (US$/oz produced) 913.0 IRR ungeared (%) 22.7 NPV 8% (US$M) 102.2 (US$/oz produced)* 634.0 Initial capital cost** (US$M) 132.3 **Excludes royalty and refining costs* ***Excludes working capital and pre-production funding* ****project metrics were re-estimated at the completion of the FS in June 2015 and resulted in marginal changes to the economics with the NPV increasing to US$112M*
Social	A socio-economic study was prepared by Golder Consultants for Nyota and this is documented in 2012 DFS that was completed by SENET for Nyota. The commentary provides a summary of the socio-economic characteristics of the area at a household level. Nyota conducted a stakeholder engagement program and survey in 2010. KEFI has commissioned a community management team and specialist Ethiopian consulting firm Dynamic which, in conjunction with the local government, has facilitated the drafting of the selection and allocation of new host lands, the compensation amounts and the livelihood restoration policy.
Classification	The Ore Reserve is classified as Probable in accordance with the JORC Code, corresponding respectively to the Mineral Resource classifications of Indicated. No Inferred Resources are included in the Ore Reserve estimate.
Audits or reviews	Snowden has completed an internal peer review of the Ore Reserve estimate. The KEFI financial model was also reviewed by Endeavour Financial Limited.
Relative accuracy/ confidence	Snowden's opinion of Ore Reserve is that the classification of Probable is reasonable. However lower confidence is attributed to the following Modifying Factors: • Dilution: The dilution for the proposed selective mining method was modelled by applying +/-0.5 m dilution zone to the Mineral Resource model, representing the average mixing of ore and waste expected to occur at the boundary by the excavator. As the mineralised lodes are typically 2 m to 3 m wide, the realised grade will be sensitive to achieving this outcome and can only be confirmed by a production reconciliation process • Mining costs: The mining costs are currently at a prefeasibility level of accuracy; however these will be upgraded to an appropriate level of accuracy for the conclusion of the current FS using OEM and project specific budget quotations from contractors • A blasting study should be undertaken for further validation of the dilution assumptions for the proposed mining method.

5.12 OPPORTUNITIES AND RISKS

5.12.1 Opportunities

Snowden makes the following recommendations for future mine planning and Ore Reserve studies to be undertaken during the execution phase of the project:

- The degree of selectivity can be better quantified assessing the suitability of:
- Dozer ripping in the saprolite and hard materials for available at surface in field trials
- Variable blast heights to leave behind contaminated material
- Field trials of dozer pushing of blasted material
- Identification of any free dig in the saprolite in field trials
- Detailed blasting timing/dynamics study to control movement as a specialised study and potentially with field trials.
- If any of the above modified mining methods prove productive then they will help minimise the effects of dilution.
- The mining costs for the study were developed using a new owner fleet for mobile plant, as supplied by the OEM. Second-hand mining fleet or the adoption of contract mining may reduce the mining costs, and these options should be investigated.
- Further exploration as infill drilling in the pit will only marginally add to the Ore Reserve as there is only a small amount of Inferred available. A program should be commenced to identify gold resources adjacent to the Tulu pit.

5.12.2 Risks

5.12.2.1 Risk assessment

A risk assessment was made on the Tulu Kapi Ore Reserve based identified high level risks relevant to the project FS plans. Snowden also recorded any specific risks relevant to the mining study in this section.

Risks were summarised in a risk table and the full risk table is provided in **Error! Reference source not found.**. The risk table was built up by listing any Ore Reserve risks in a broader sense, but also specific mining risks that may be smaller in nature. Risks were categorised in terms of likelihood and consequence in a risk matrix. The likelihood of a risk occurring was ranked from A (almost certain) to E (rare) using the definitions shown in Table 5.57.

Table 5.57 Risk likelihood rankings

Level	Descriptor	Description
A	Almost certain	Is expected to occur in most circumstances
B	Likely	Will probably occur in most circumstances
C	Possible	Might occur at some time
D	Unlikely	Could occur at some time
E	Rare	May occur only in exceptional circumstances

The consequence of a risk was ranked from 1 (catastrophic) to 5 (insignificant) using the rankings as shown in Table 5.58.

Table 5.58 Risk consequence rankings

Consequence or impact on the resource	
Level	**Descriptor**
1	Catastrophic
2	Major
3	Moderate
4	Minor
5	Insignificant

A risk is considered to fall under four broad categories as:

- Health and safety
- Environment
- Community
- Financial.

The definitions for the consequences specific to the four categories are shown in Table 5.59.

Table 5.59 Risk category consquences

Level	Category	Health and safety	Environment	Community	Financial
1	Catastrophic	Single fatality or permanent disability.	Major offsite release, long term environmental damage. Remediation in terms of years.	Widespread reputation loss to more than one business unit, extreme community outcry nationally.	> US$100M
2	Major	Extensive injuries. No chronic health outcome.	Major offsite release, short to medium term environmental damage. Remediation in terms of months.	Widespread reputation loss to single business unit, widespread community outcry.	US$10M to US$100M
3	Moderate	Lost time injury or short/ to medium term health problem.	Offsite release with no significant environmental damage. Remediation in terms of weeks.	Regional reputation loss. Local community outcry.	US$1M to US$10M
4	Minor	Medical treatment required or short term acute health effects.	Major release on site, no offsite damage. Remediation in terms of days.	Local client concern, local community concern.	US$10K to US$1M
5	Insignificant	Local treatment with short recovery.	Onsite release, containable with minimal damage.	Workforce concern, no community concern.	< US$10K

The matrix of likelihood and consequence is shown in Table 5.60.

Table 5.60 Likelihood and consequence matrix

consequence		Category	likelihood A Almost Certain	B Likely	C Possible	D Unlikely	E Rare
	1	Catastrophic	High	High	High	High-medium	Medium
	2	Major	High	High	High-medium	Medium	Low
	3	Moderate	High	High-medium	Medium	Low	Low
	4	Minor	High-medium	Medium	Low	Low	Low
	5	Insignificant	Medium	Low	Low	Low	Low

5.12.2.2 Key risks identified

The key risks identified as relevant to mining activities and the Ore Reserve are summarised in Table 5.61.

Table 5.61 Tulu Kapi key mining risks

Risk	Current risk rating	Comment
The gold price falls	High-medium	Based on KEFI research as outlooks
Lower than expected recovery	Medium	Adequate testwork in the FS
Regular fuel supply interrupted	Medium	Excess storage capacity and delivery schedule is appropriate
Ore being misallocated into waste dumps, bad blast practice mixing ore and waste	Medium	Suitable operational practices, grade control for delivery of ore/waste. A process of mine to product reconciliation is recommended
Waste being delivered to the ROM, dig patterns not followed	Medium	Grade control program is sufficient to identify performance of the resource model. A process of mine to product reconciliation is recommended
Poor operator practice, inappropriate equipment for mining operation, insufficient mining fleet, lack of contract controls	Medium	A reputable contractor with equipment adequate for task is negotiating with KEFI
Diesel price rise	Medium	Used SENET specified prices as quotes from major international suppliers
Injury or fatality on public road from mine vehicle	Medium	Signage, bunding, maintenance and training
Damage rioting or strikes at the mine	Medium	Effective community engagement and local recruitment policy.
Disease outbreak on site (e.g. malaria, Ebola etc.)	Medium	Effective mosquito controls, WHO guidelines in use, Malaria fogging and disease control programs for employees and visitors
Acid run-off stockpiles and waste dumps	Medium	The Nyota SEIA (2012) does not see ARD as an issue
Noise pollution creating unrest in communities	Medium	Restrict blasting to daylight hours, effective community engagement

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SECTION 6 Metallurgical Testwork and Process Plant Design

Tulu Kapi Gold Project Definitive Feasibility Study

JULY 2015

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6.1 METALLURGICAL TESTWORK

6.1.1 Introduction

Metallurgical testwork was carried out on various samples of oxide and fresh Tulu Kapi ore types for the Pre-Feasibility Study (PFS), and the results were detailed in ALS AMMTEC's final report (A12931) dated September 2011 (see Annexure 6-1).

This testwork, which included a mineralogical study of the Tulu Kapi ore, investigated the comminution requirements as well as the alternative process routes of flotation, gravity recovery and cyanidation leaching for gold recovery.

Further testwork was initiated in January 2012 and completed in July 2012 as part of the Definitive Feasibility Study (DFS) to confirm gold recovery efficiencies through a combination of gravity separation and cyanidation leaching as well as tailings detoxification and additional comminution testwork to support the process design parameters for a conventional gold recovery plant.

The recovery of associated silver values was monitored throughout the testwork to investigate the potential effect on gold recovery and with a view to predicting the anticipated silver content in the doré that will be produced.

Samples for this testwork were provided in various separate lots:

- A bulk composite of fresh ore sample remnants from the earlier PFS testwork used to support initial process design parameters for the carbon-in-leach (CIL) circuit
- Core samples of the various ore types selected from the intersects of one, new and centrally located borehole specifically chosen to target the full range of ores, from oxide to shallow fresh ore (Lode 1) down to the harder fresh ore (Lode 3) for both comminution and extraction testwork
- Core samples from several shallow depth holes to provide sufficient quantities of competent oxide ore suitable for comminution testwork and extraction variability testwork
- Saprolite oxide core and pit samples for extraction variability testwork
- Quarter-core fresh ore samples from selected existing boreholes to allow for a comprehensive variability study of both comminution and leach extraction data

ALS Ammtec (AMMTEC) was appointed to carry out the testwork programme.

Orway Mineral Consultants (OMC) was appointed to review the PFS testwork results and to manage the DFS testwork programme.

A value engineering exercise was also conducted by SENET to examine the gravity concentration and oxygen uptake testwork with the objective of reducing the process flowsheet to what is essential for gold recovery. The following was investigated:

- Removal of the gravity circuit if conventional cyanide leaching recovered sufficient gold
- Kinetics and gold extraction efficiencies achieved using air sparging in the leaching circuit

6.1.2 Testwork Results and Observations

The results of the testwork from both the PFS and the DFS campaigns are summarised in Annexure 6-1.

These results indicated the following:

- The oxide and transitional ores are of medium hardness and fresh ore becomes harder with increasing depth.
- All the ore types (oxides and fresh) are amenable to gold extraction by conventional cyanidation.
- Leach dissolutions of 97.4 % and 96.4 % were obtained for oxides and deep hard fresh, respectively at a grind size of P_{80} of 75 µm in a leach time of 24 h.
- Recovery testwork with and without gravity separation showed that gravity separation did not significantly increase overall gold recovery. Therefore ROM cyanidation was the selected process route.
- Leach optimisation testwork showed the following optimum parameters:

    - Optimum grind: 80 % passing 75 µm
    - Optimum initial cyanide concentration: 0.035 % NaCN
    - Presence of preg-robbers: 1.75 % therefore CIL circuit selected
    - Residence time: 24 h

6.1.2.1 Comminution

Comminution testwork carried out on the different ore types provided the design data given in Table 6-1. Refer to Annexure 6-2 for a detailed report on the testwork conducted to determine the JK Functions.

Table 6-1: Comminution Testwork Summary

Parameter	Unit	Oxide	Fresh	Harder Fresh
Unconfined Compressive Strength (UCS) – Average	MPa	87.9	-	-
Abrasion Index (Ai)	kWh/t	0.314	0.39	0.6522
Crushing Work Index (CWi)	kWh/t	8.2	11.4	12.9
Rod Mill Work Index (RWi):				
P_{80}	µm	946	933	791
RWi	kWh/t	11.3	12.2	19.7
Ball Mill Work Index (BWi):				
P_{80}	µm	90	89	82
BWi	kWh/t	15.5	15.5	18
RWi/BWi ratio	-	0.73	0.79	1.09
JK Functions, A × b		111.9	81.8	38.6

From the comminution results summarised in Table 6-1 above, the oxide ore and soft fresh ore evidently have a medium hardness whereas the harder fresh ore, found at depths greater than 150 m below ground level, is characterised as a hard ore.

The harder fresh ore is more resistant to impact breakage (within the 38 and 46 range) thus emphasising the competency of this ore type. The oxide ore and soft fresh ore have larger JK function values, which are in line with softer ores.

6.1.2.2 Grind Optimisation and Selection

The grind size comparison of extraction efficiencies during the PFS testwork suggested that a P_{80} = 75 µm grind would provide an improvement of approximately 0.03 g/t additional gold recovery. At 75 µm grind size, a leach dissolution of 97.3 % Au was achieved whereas the 150 µm grind size achieved a 96.6 % Au dissolution.

Further grind optimisation testwork was conducted during the 2012 DFS to confirm the quantity of additional gold recovery from a P_{80} = 75 µm grind. Table 6-2 below summarises the leach dissolution that was achieved from the 75 µm grind size compared to coarser grinds up to the 150 µm grind size.

Table 6-2: Grind Optimisation Testwork on Fresh and Hard Fresh Ore

Test No.	Grind Size (µm)	Calculated Head Au (g/t)	Solids Tail Au (g/t)	Gravity Recovery (%)	48 h Leach Dissolution (%)	Total Dissolution (%)
BK199	75	1.62	0.05	N/A	96.91	96.91
BK415	106	2.02	0.08	N/A	96.04	96.04
BK414	125	1.96	0.09	N/A	95.41	95.41
BK413	150	2.67	0.11	N/A	95.89	95.89
BK309	75	1.76	0.05	51.53	45.63	97.16
BK523	106	2.02	0.075	15.21	81.07	96.28
BK522	125	1.9	0.1	16.15	78.58	94.73
BK521	150	2.52	0.11	12.2	83.44	95.63
BK526	106	3.11	0.11	33.9	62.73	96.62
BK525	125	3.17	0.11	33.25	63.43	96.69
BK524	150	3.23	0.11	32.59	64.01	96.6

Grind optimisation carried out prior to the oxide bulk composite leach testwork also compared the extraction efficiency of changing from a 75 µm grind size to a 150 µm grind size; the results are given in Table 6-3 below.

Table 6-3: Grind Optimisation Testwork on Oxide Ore

Test No.	Grind Size (µm)	Calculated Head Au (g/t)	Solids Tail Au (g/t)	Dissolution (Au %)
BK445	75	3.22	0.09	97.2
BK444	106	3.23	0.1	96.9
BK443	125	3.56	0.11	96.9
BK442	150	3.20	0.16	95.0
BK441	212	3.65	0.33	91.0

Due to the power constraints that were applicable at the beginning of the study, the 2012 DFS circuit design and initial DFS testwork were based on a P_{80} = 150 µm grind size.

After further discussions with EEPCo, the Client has advised that the grid power available will be sufficient for the Tulu Kapi project. Therefore, the power constraints applicable at the beginning of the 2012 DFS no longer applied. This allowed for additional testwork to be conducted on a 75 µm grind size.

From the testwork results, a grind trade-off study was performed comparing the two grind sizes: 75 µm and 150 µm. The trade-off study was based on the average resource grade from the mine schedule developed in July 2012. Table 6-4 provides a summary of the grind size versus recovery trade-off study and confirms the advantages of applying a 75 µm grind size.

Table 6-4: High-Level Grind vs Recovery Trade-Off Summary (150 µm and 75 µm)

Description	Unit	150 µm Grind	75 µm Grind
Annual Tonnage Processed	tpa	2 000 000	2 000 000
LOM	Year	6.36	6.36
Gold Price	USD/oz	1 500	1 500
Total Comminution Liner and Grinding Cost	USD/t	1.49	1.98
Total Reagent Cost	USD/t	1.14	0.94
Total Power Cost	USD/t	0.32	0.47
Total LOM Operating Costs	**USD/t**	**2.94**	**3.38**
LOM Operating Costs	**USD**	**37 361 758**	**43 145 348**
Total Mills Capital Cost	**USD**	**10 799 406**	**11 196 206**
Total LOM Costs	**USD**	**48 161 164**	**54 341 554**
Head Grade	g/t	1.57	1.57
Total Circuit Recovery	%	92.2 %	94.6 %
Gold Price	USD/oz	1 500	1 500
Annual Recovered Gold	kg	2 894	2 971
Annual Recovered Gold	oz	93 047	95 512
Annual Gold Gross Revenue	USD	139 570 848	143 268 316
LOM Gold Gross Revenue	**USD**	887 930 960	911 453 756
LOM Revenue less Costs	**USD**	**839 769 796**	**857 112 202**
LOM Difference (150 µm vs 75 µm)	**USD**	**17 342 406**	

Over the life of mine (LOM) there is a definite benefit to using 75 µm as the selected grind size. At 75 µm grind, there is an estimated increase in undiscounted revenue of around $17 million.

6.1.2.3 Gravity Recovery

AMMTEC's testwork results indicated significant quantities of gravity recoverable gold throughout the orebody and subsequent definitive EGRG testwork was carried out by Gravity Concentrators Africa (GCA) (see Annexure 6-3). AMMTEC's results indicated a wide range of free gold present in the ore, from approximately 14 % Au up to 55 % Au. Testwork, followed by modelling by GCA, predicts a gravity recovery of 48 % at the design gravity circuit throughput.

Based on testwork that compared the results with and without gravity separation, gravity recovery of free gold was not considered to provide a significant increase in the overall gold recovery. However, the possibility of a gravity circuit should not be ruled out. Ongoing assessments should be conducted and plant operational indicators monitored to determine the need for a gravity circuit.

6.1.2.4 Thickening

Thickening testwork was carried out on slurry samples of the leach tailings to provide design data (see Annexure 6-4 for the detailed testwork results).

The testwork has shown that the fresh ore tailings slurry, at a P_{80} of 150 µm, can be successfully thickened at high flux rates. Testwork also returned high densities of slurry ranging from 60 % to 63 % w/w (thus achieving the target density of 50 % to 60 % w/w solids). The overflow water displayed clarities of less than 100 ppm with 5 g/t to 10 g/t of flocculant at pH 10.8.

The oxide ore tailings material, also at a P_{80} of 150 µm, would require a high pH of 10.8 to maintain high underflow density and good overflow clarity, including stable flocculant formation.

However, in view of the need for cyanide detoxification, the requirement for a tailings thickener became irrelevant.

Thickening of the leach feed will be achieved with cyclones only and has been confirmed for the 150 µm and 75 µm grind sizes.

6.1.2.5 Cyanide Optimisation

Testwork indicated an optimised initial cyanide concentration of 0.035 % NaCN; this cyanide concentration was used for all the subsequent testwork including variability testwork. The optimum cyanide concentration for the CIL circuit will be determined during operations.

6.1.2.6 Cyanide Detoxification

The destruction of WAD cyanide levels in leach slurry tails was tested using both hydrogen peroxide (H_2O_2) and SO_2/air. A snapshot of the results is given in Table 6-5.

Table 6-5: Cyanide Destruction Testwork Summary

Ore Sample	pH	Retention Time (min)	H_2O_2 Addition (mol/mol CN)	SO_2/Air			Solution Assays		
				SO_2 (g/g CN_{WAD})	Cu^{2+} (mg/L)	Lime (g/g SO_2)	Feed CN_p (mg/L)	Treated CN_p (mg/L)	Treated CN_{total} (mg/L)
Fresh	9.94	30	3.99	-	-	-	109	57.2	-
	8.53	18	-	2.28	80	1.25	109	< 0.21	< 1.75
Oxide	10.35	30	4.00	-	-	-	137	95.8	-
	8.50	60	-	2.3	76	0.47	137	1.7	4.63

Hydrogen peroxide results are well above the 50 ppm CN_{WAD} target level, particularly in the case of oxide ores. The SO_2 results for both fresh ore and oxide ore, however, were well below the target level and generally below 10 ppm CN_{WAD}.

6.1.2.7 Oxygen Uptake

The oxygen uptake of both the oxide and fresh ore master composite samples, determined as a function of time, demonstrated that the ores have a very low oxygen demand which is satisfied rapidly. Oxygen uptake values of 0.018 mg/L/min and 0.008 mg/L/min were achieved for the oxide and fresh ore, respectively.

The testwork results might suggest that the use of oxygen may not be necessary for optimum dissolution of gold. However, the inclusion of an oxygen sparge in the flowsheet is recommended as a safety net for plant operations.

6.1.2.8 Carbon Adsorption

Equilibrium adsorption testwork indicated that the carbon loading capacity, for both gold and silver, was in line with industry norms. With a solution tenor of 1 mg/L Au equilibrium carbon loadings of 6 864 g/t Au and 3 502 g/t Au were achieved for the oxide and fresh ore respectively

6.1.2.9 Variability Testwork

A total of 32 samples from various locations as shown in Figure 6-1 below were subjected to specific testwork to assess variability within the orebody, including both gold recovery and comminution.

These samples comprised the following:

- 11 samples from geographically diverse oxide sources for grindability and extraction testwork
- 16 samples from spatially diverse fresh ore sources specifically for extraction testwork

- 5 samples from spatially diverse fresh ore sources for both comminution variability and extraction testwork

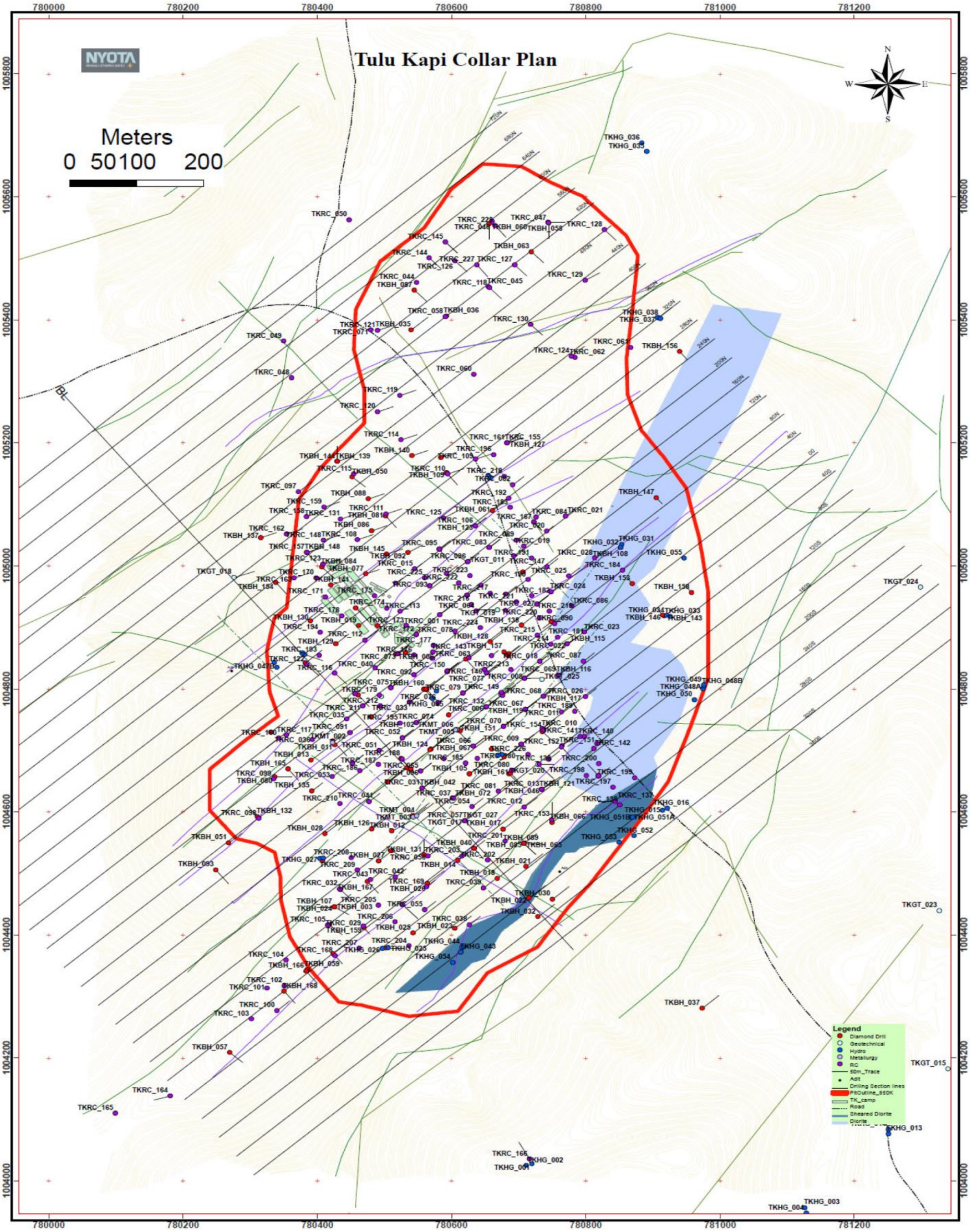

Figure 6-1: Consolidated Overall Drill Hole Collar Plan

Soft fresh ore recoveries at P_{80} = 150 µm range between 85.3 % and 94.7 % for gold and 37.1 % and 82.1 % for silver (see Table 6-6).

Table 6-6: Soft Fresh Ore Au and Ag Variability Results at 150 µm

Sample ID	Feed		Recovery	
	Au (g/t)	Ag (g/t)	Au (%)	Ag (%)
V-1	1.31	0.90	92.7	63.1
V-2	1.56	0.60	93.8	70.6
V-3	2.95	1.45	94.7	56.3
V-4	2.44	1.09	89.2	60.5
V-5	3.07	1.02	91.8	82.0
V-6	1.61	1.05	90.3	49.5
V-7	1.72	2.92	93.1	37.1
V-8	2.77	1.04	93.8	82.1
V-17	1.34	0.61	85.3	71.0
V-18	1.46	0.52	89.6	66.5

Hard fresh ore recoveries at P_{80} = 150 µm range between 69.7 % and 95.6 % for gold and 36.7 % and 85.8 % for silver (see Table 6-7).

Table 6-7: Hard Fresh Ore Au and Ag Variability Results at 150 µm

Sample ID	Feed		Recovery	
	Au (g/t)	Ag (g/t)	Au (%)	Ag (%)
V-9	1.94	0.82	92.6	77.8
V-10	1.29	0.62	90.7	71.4
V-11	1.87	1.32	88.9	66.9
V-12	3.38	1.28	95.6	85.8
V-13	2.47	1.17	91.7	84.1
V-14	1.94	2.19	87.3	43.5
V-15	0.93	0.44	89.3	60.4
V-16	1.60	0.57	87.5	69.3
V-19	1.40	0.41	92.8	58.3
V-20	2.05	0.59	93.3	70.2
V-21	0.37	0.27	69.7	36.7

Oxide ore recoveries at P_{80} = 150 µm range between 88.2 % and 96.0 % for gold and 59.7 % and 95.7 % for silver (see Table 6-8).

Table 6-8: Oxide Ore Au and Ag Variability Results at 150 µm

Sample ID	Feed		Recoveries	
	Au (g/t)	Ag (g/t)	Au (%)	Ag (%)
V-2	2.35	0.43	94.4	59.7
V-3	3.83	0.52	92.1	66.5
V-4	0.99	0.45	93.8	61.7
V-5	1.96	0.78	96.0	77.0
V-6	2.53	0.61	88.2	71.3
V-8	2.45	2.20	92.6	91.3
V-9	1.15	3.83	92.6	89.6
V-10	1.15	2.83	89.9	92.0
V-11	1.48	5.35	90.1	95.7
V-12	2.10	2.79	90.5	92.1

Further leaching testwork, based on a P_{80} = 75 µm grind size, was completed. Table 6-9 to Table 6-11 highlight the difference in residue grades between 75 µm and 150 µm grind sizes using the same variability samples under identical test conditions.

Table 6-9: Au Solids Tail Grade Comparison for Oxide Ore

Sample ID	Au Head Grade			Au Solids Tail Grade		ΔAu Solids Tail Grade
	Assay	Calculated				
		75 µm	150 µm	75 µm	150 µm	
	(g/t)	(g/t)	(g/t)	(g/t)	(g/t)	(g/t)
V-2	3.23 / 3.27 / 5.44	2.24	2.35	0.075	0.07	-0.005
V-3	3.96 / 3.34 / 3.53	3.97	3.83	0.18	0.22	0.035
V-4	0.79 / 1.02 / 0.75	1.15	0.99	0.01	0.03	0.02
V-5	1.79 / 1.88 / 1.98	1.86	1.96	0.03	0.04	0.01
V-6	2.40 / 2.78 / 2.09	1.85	2.53	0.1	0.24	0.14
V-8	2.49 / 3.10 / 3.42	2.68	2.45	0.05	0.13	0.08
V-9	0.83 / 1.04 / 1.33	1.48	1.15	0.05	0.05	0
V-10	1.14 / 0.99 / 1.20	0.94	1.15	0.04	0.08	0.04
V-11	1.45 / 1.14 / 1.05	4.09	1.48	0.28	0.10	-0.18
V-12	1.59 / 2.33 / 3.45	2.00	2.10	0.055	0.15	0.095
Average		**2.23**	**2.00**	**0.09**	**0.11**	**0.024**

Table 6-10: Au Solids Tail Grade Comparison for Soft Fresh Ore

Sample ID	Au Head Grade			Au Solids Tail Grade		ΔAu Solids Tail Grade
	Assay	Calculated				
		75 µm	150 µm	75 µm	150 µm	
	(g/t)	(g/t)	(g/t)	(g/t)	(g/t)	(g/t)
V-1	1.50 / 1.30 / 0.88	1.01	1.31	0.04	0.06	0.015
V-2	1.25 / 1.52 / 1.38	1.52	1.56	0.06	0.05	-0.01
V-3	2.24 / 2.49 / 2.62	2.57	2.95	0.13	0.09	-0.04
V-4	2.40 / 2.30 / 2.91	2.39	2.44	0.14	0.20	0.06
V-5	1.97 / 2.61 / 2.50	2.69	3.07	0.12	0.18	0.06
V-6	1.36 / 1.38 / 1.26	1.93	1.61	0.07	0.11	0.04
V-7	1.24 / 1.73 / 2.66	1.53	1.72	0.05	0.07	0.02
V-8	1.37 / 1.45 / 2.81	2.04	2.77	0.11	0.11	0
V-17	1.44 / 1.76 / 1.22	1.34	1.34	0.06	0.16	0.1
V-18	1.29 / 1.03 / 1.13	1.14	1.46	0.06	0.11	0.05
Average		**1.82**	**2.02**	**0.08**	**0.11**	**0.030**

Table 6-11: Au Solids Tail Grade Comparison for Harder Fresh Ore

Sample ID	Au Head Grade			Au Solids Tail Grade		ΔAu Solids Tail Grade
	Assay	Calculated				
		75 µm	150 µm	75 µm	150 µm	
	(g/t)	(g/t)	(g/t)	(g/t)	(g/t)	(g/t)
V-9	1.96 / 2.08 / 2.20	2.38	1.94	0.06	0.09	0.03
V-10	1.34 / 0.40 / 1.24	1.34	1.29	0.07	0.08	0.01
V-11	1.22 / 1.33 / 0.94	1.43	1.87	0.13	0.16	0.025
V-12	2.19 / 1.24 / 1.39	4.60	3.38	0.06	0.09	0.03
V-13	2.02 / 2.67 / 2.35	1.90	2.47	0.06	0.15	0.085
V-14	2.42 / 2.47 / 2.18	1.94	1.94	0.16	0.20	0.04
V-15	1.16 / 0.95 / 4.01	1.29	0.93	0.05	0.07	0.02
V-16	1.66 / 1.76 / 1.93	2.20	1.60	0.08	0.16	0.08
V-19	1.42 / 1.14 / 1.34	1.49	1.40	0.05	0.06	0.01
V-20	3.44 / 3.49 / 3.22	2.27	2.05	0.11	0.08	-0.03
V-21	0.50 / 0.38 / 0.54	0.52	0.37	0.17	0.09	-0.08
Average		**1.94**	**1.75**	**0.09**	**0.11**	**0.020**

Using the average feed and solids tail grade, together with the average gravity recovery, and applying a 97.5 % CIL dissolution confidence factor (as was done for the 150 µm grind size), the average metallurgical performance at P_{80} = 75 µm grind size (using the optimised conditions for the three ore types used for the 2012 DFS) is summarised in Table 6-12 below.

Table 6-12: Average Testwork Results for the Three Types of Ore at 75 µm

Ore Type	Au		Ag		Average Solids Tails		Calculated Recovery	
	Average Feed (g/t)	Average Gravity Recovery (%)	Average Feed (g/t)	Average Gravity Recovery (%)	Au g/t	Ag g/t	% Au	% Ag
Oxide	2.05	38	1.75	21	0.082	0.150	90.4	86.0
Fresh	1.82	38	0.91	21	0.084	0.370	89.3	45.1
Harder Fresh	1.94	29	1.36	13	0.091	0.668	90.2	41.0

Various anomalies were found in the results comparing the 150 µm vs the 75 µm testwork. The criterion used to identify an anomaly was that of the Au solids tail grade for which the 75 µm was either less or the same as that for the 150 µm. The tests listed in Table 6-13 were discarded because they were anomalies. Their results are shown in Table 6-9 to Table 6-11.

Table 6-13: Tests Discarded from Data Set

Oxide	Soft Fresh	Hard Fresh
V-2	V-2	V-20
V-9	V-3	V-21
V-11	V-8	

In order to generate the curve that would predict the average performances (at P80 = 75 µm grind using optimised conditions for the average resource), the tests listed in Table 6-13 were eliminated from the data set.

6.1.3 Head-Tails Relationships

The results of the cyanidation testwork for the oxide, soft fresh and hard fresh samples are shown in Table 6-14, Table 6-15 and Table 6-16 respectively.

Table 6-14: Cyanidation Test Results for Oxide Samples

Orebody	Ore Type	Sample ID	Head Grade (g/t)	Tails Grade (assayed)
Tulu Kapi	Oxides	V-3	3.97	0.18
		V-4	1.15	0.01
		V-5	1.86	0.03
		V-6	1.85	0.10
		V-8	2.68	0.05
		V-10	0.94	0.04
		V-12	2.00	0.06

Table 6-15: Cyanidation Test Results for Soft Fresh Samples

Orebody	Ore Type	Sample ID	Head Grade (g/t)	Tails Grade (assayed)
Tulu Kapi	Soft Fresh	V-1	1.01	0.04
		V-4	2.39	0.14
		V-5	2.69	0.12
		V-6	1.93	0.07
		V-7	1.53	0.05
		V-17	1.34	0.06
		V-18	1.14	0.06

Table 6-16: Cyanidation Test Results for Hard Fresh Samples

Orebody	Ore Type	Sample ID	Head Grade (g/t)	Tails Grade (assayed)
Tulu Kapi	Hard Fresh	V-9	2.38	0.06
		V-10	1.34	0.07
		V-11	1.43	0.13
		V-12	4.60	0.06
		V-13	1.90	0.06
		V-14	1.94	0.16
		V-15	1.29	0.05
		V-16	2.20	0.08
		V-19	1.49	0.05

The results were used to establish relationships between the head grades and the tailings grades for the different ore lithologies. The relationships for the respective lithologies are shown in Figure 6-2 to Figure 6-4. Some results were identified to be anomalous and these were excluded from the data points used to establish the head-tails relationships. The data points excluded from the correlations are labelled in red. These anomalous results could have resulted from analytical errors, or some anomalous metallurgical cyanidation characteristics for some specific samples.

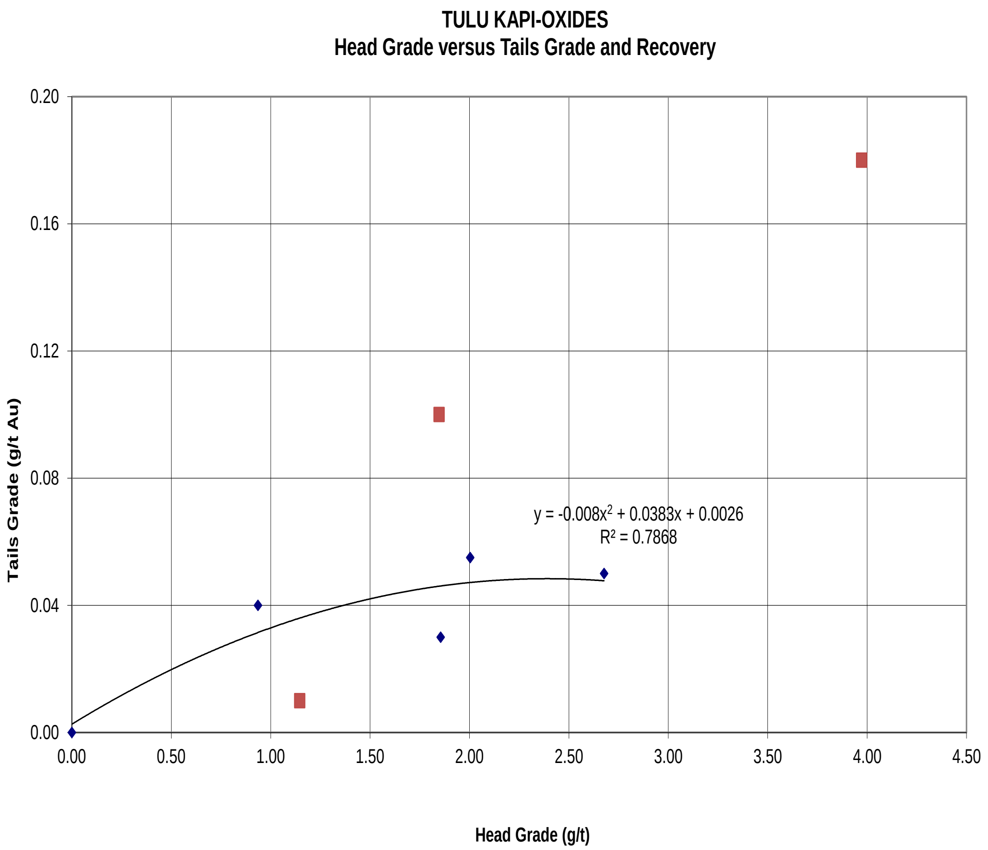

Figure 6-2: Tails- Head Grade Relationship- Oxides

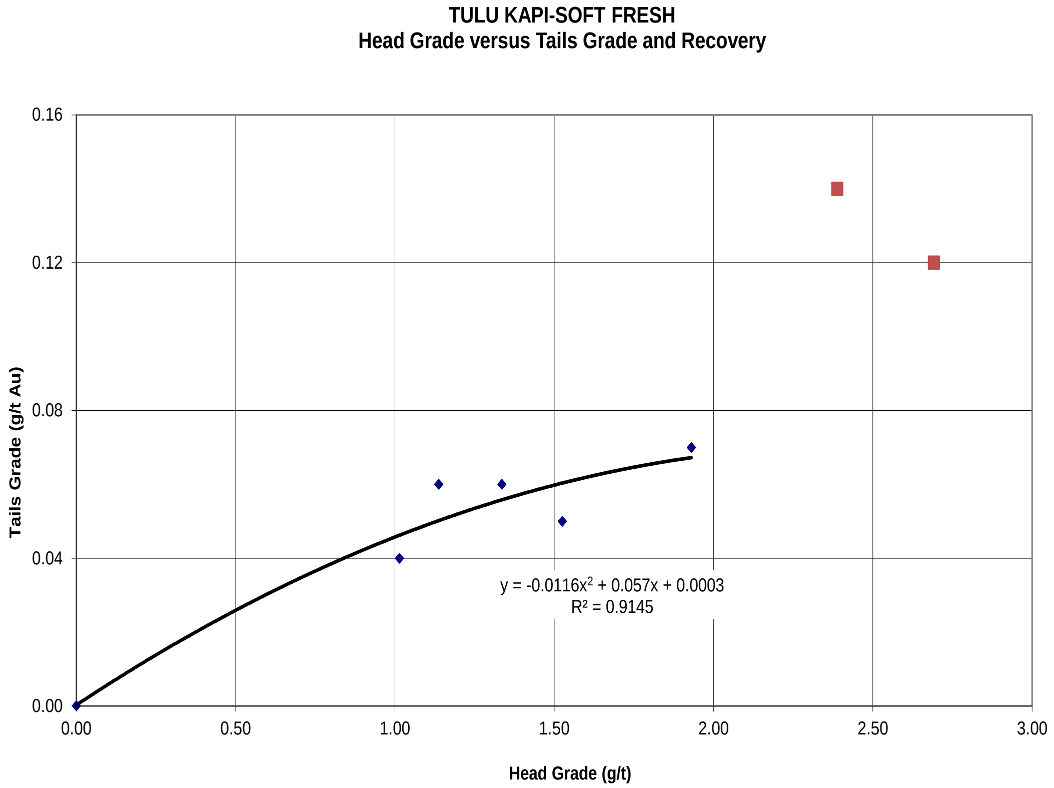

Figure 6-3: Tails- Head Grade Relationship- Soft Fresh

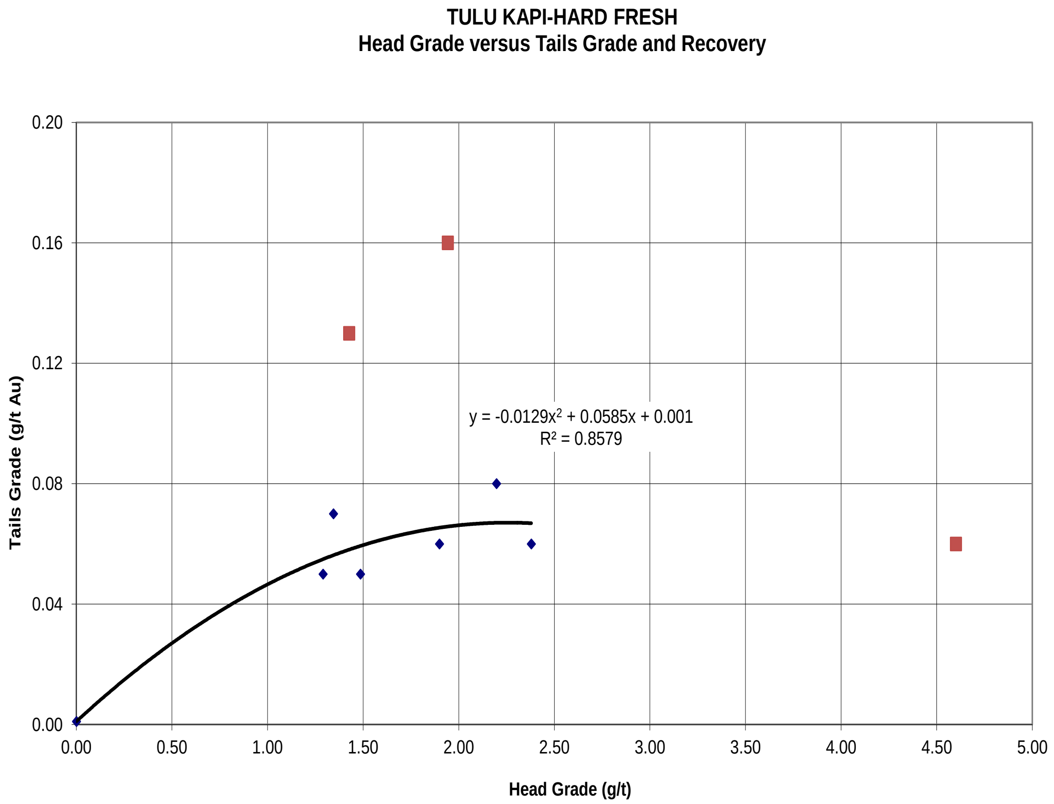

Figure 6-4: Tails- Head Grade Relationship- Hard Fresh

The relationships established from the head-tails plots were used to calculate the tails grades for a range of head grades. The calculated tails were then used to establish head-recovery relationships for different ore types. The recoveries were calculated with a confidence level of 95 %. The grade-recovery relationships for the three types of ores are shown in Figure 6-5.

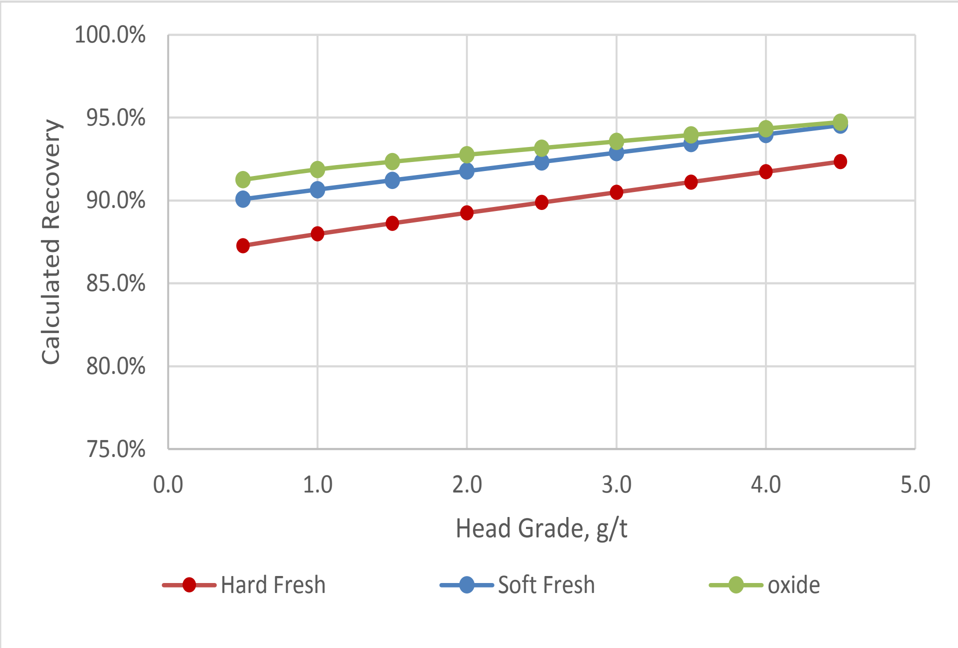

Figure 6-5: Grade-Recovery Curves

The following can be concluded from the testwork results and analysis thereof:

- The grade-recovery relationships show a steady increase in recovery as the head grade increases.
- The following recovery versus feed grade (H) relations were established:

Oxide:	Recovery = (H- (H*(0.0383 – 0.008*H) + 0.0026))/H*0.95
Soft Fresh:	Recovery = (H- (H* (0.057 – 0.0116 * H) + 0.003))/H*0.95
Hard Fresh:	Recovery =H-(H* (0.0585 – 0.0129 * H) + 0.001))/H*0.95

- Recovery declines as the ore becomes more competent. This is in line with natural liberation characteristics of the differently weathered ore types.
- The recoveries range from 85 % for low grade hard fresh samples to 95 % for high grade oxide samples.

6.1.4 Conclusions

Table 6-17 shows a summary of the testwork results. These results or outcomes were used in developing the process flowsheet and the design criteria.

Table 6-17: Summary of the Testwork Results

Comminution Testwork	Unit or Type	Oxide Comp	Fresh Comp Lode 1	Fresh Comp Lode 2
Abrasion Index	g	0.3139	0.3898	0.6522
BRWi	kWh/t	11.3	12.2	19.7
BBWi (106 µm)	kWh/t	15.5	15.5	18
JK Drop Weight	A × b	111.9	81.8	38.6
	ta	1.07	0.72	0.29
Leach Optimisation Testwork	Optimum grind	80 % - 75 µm		
	Optimum cyanide addition	0.0035 % NaCN maintained		
	Preg robbers (oxides)	1.75 % therefore CIL circuit		
	Optimum residence time (h)	24		
Gold Dissolution	Oxide (%)	97.4		
	Deep Fresh (%)	96.4		
Cyanide Consumption	Oxide (kg/t)	0.28		
	Deep Fresh (kg/t)	0.13		
Oxygen Uptake	Oxides (mg/L/min)	0.018		
	Fresh (mg/L/min)	0.008		
Carbon Loading Kinetics and Equilibrium	Carbon loading -Oxides (g/t Au)	6864		
	Carbon loading - Fresh (g/t Au)	3502		
Cyanide Detoxification	Selected Process	INCO		
	Residual cyanide (CN_{WAD}-ppm)	5		
	Residence time (min)	60		
	Reagent consumption (g SO_2/g WAD)	2.30		

6.2 PROCESS DESCRIPTION

6.2.1 Introduction

The Tulu Kapi Process Plant will be designed utilising the proven CIL process technology for the treatment of oxide, softer fresh and hard fresh ore.

The process description consists of the following sections:

- Crushing, stockpiling and reclaim
- Grinding and classification
- Trash handling
- CIL plant
- Cyanide detoxification
- Tailings disposal
- Acid wash
- Elution
- Carbon regeneration
- Electrowinning (CIL) and smelting
- Water and air services
- Reagents

6.2.2 Crushing, Stockpiling and Reclaim

The crushing circuit will comprise single-stage crushing when treating oxide ore or blends of oxide and shallow fresh ore during the early years of production (Phase 1). It will then move to Phase 2 where a secondary crushing stage will be added to treat blends of shallow fresh and deep fresh ores.

Run-of-mine (ROM) ore will be transported from the pit to the gold extraction plant using dump trucks. The ROM ore will be dumped directly onto the static grizzly on top of the 70 m^3 capacity tipping bin (22-BINS-001). The grizzly (22-GRIZ-001), mounted above the ROM bin, will scalp off the oversize material, which can be broken down to the right size using the rock breaker (22-RBKR-001). Excess use of the rock breaker indicates that mining is producing off-specification feed in terms of size.

The crushing plant will operate at a crushing rate of 220 tph, treating feed ore from a maximum lump size of 800 mm to a product size of 80 % passing 122 mm, which is suitable for semi-autogenous grinding (SAG) milling.

Ore will be reclaimed from the ROM bin using a variable speed apron feeder (22-APRF-001), and will be discharged onto a static screen (22-SCRA-001) with 125 mm spacing. The screen oversize will report to the primary jaw crusher (22-CRUJ-001), where it will be reduced to 100 % passing

220 mm. Surges in the crusher feed will be reduced by the action of heavy chains hung above the apron feeder discharge from the bin structure. The jaw crusher discharge, the static screen undersize, and the apron feeder dribblings will report to the crusher discharge conveyor (22-CONV-001). The combined stream will be discharged via a diverter chute (22-DIVC-001) onto the stockpile feed conveyor (22-CONV-002) during Phase 1, and onto the screen feed conveyor (22-CONV-004) in the secondary crushing circuit during Phase 2 of the project. The stockpile feed conveyor will transfer the material to the mill feed stockpile and the screen feed conveyor will transfer the material to the secondary crushing circuit.

The screen feed conveyor will discharge crushed product onto the double-deck vibrating screen (22-SCRD-001). The top deck of the screen will be used as a scalping screen with apertures of 125 mm × 125 mm. The second deck will produce a mill feed product size of 100 % passing 32 mm. The screen undersize will discharge onto the screen undersize conveyor (22-CONV-005), which transfers the material to the stockpile feed conveyor. The top and bottom screen oversize will discharge onto a secondary bin feed conveyor (22-CONV-003), which will transfer the material to the secondary bin. A variable speed pan feeder will be used to withdraw material from the bin to feed the secondary crusher (22-CRUC-001) at a controlled rate in order to achieve and maintain choke feed conditions. Secondary crusher product will discharge onto the screen feed conveyor.

The crusher circuit product will be transferred to the crushed ore stockpile, which is designed for 3 600 t (live) capacity. From the stockpile, the material will be withdrawn using any two of the three pan feeders (24-FEDP-001/002/003), each with a variable speed drive to ensure that a controlled mill feed rate is achieved. The pan feeders will discharge the material onto the mill feed conveyor (24-CONV-001), which will transfer the ore to the mill feed hopper.

Two hoists (22-HYST-001/002) will be installed for use on the jaw crusher, apron feeder, and general crushing area, and will facilitate maintenance and dislodging of chokes in the event of oversized rocks reporting to the crusher.

In any mining operation, it is inevitable that tramp iron will find its way into the system. This tramp iron poses a danger to downstream equipment and will need to be removed. For this purpose, two magnets (22-MAGT-001 and 22-MAGT-002) the first magnet will be installed on the stockpile feed conveyor and the second magnet will be installed on the second bin feed conveyor; both are installed to remove tramp metal from the ore stream. The electromagnets will be supported from manual chain block hoists, from which they can be removed to facilitate cleaning and removal of tramp iron to a waste bin.

Conveyors in the crushing area will be covered (with doghouse sheeting) to protect the material from the heavy annual rainfall.

The stockpile area spillage will be contained in a bund and pumped to the mill discharge pump via a sump pump (24-PMPV-001).

Dust containment will be effected by the use of skirting, dust enclosures, and dust suppression systems (22-DUSP-001 and 24-DUSP-001), which will use fine water sprays at the main dust-generating points: ROM bin tipping point, ROM bin discharge, jaw crusher discharge, and stockpile area.

The use of skirting and a ventilation fan (24-EFAN-001) will assist with the containment and control of dust underneath the stockpile.

6.2.3 Grinding and Classification

The grinding circuit will use the SAG mill as the primary mill and a ball mill for regrinding. The milling circuit will handle 150 tph of a blend of oxide and shallow fresh ore during the first few years of the LOM and thereafter 150 tph of a blend of shallow and deep fresh ore.

Crushed ore is withdrawn from the stockpile at a controlled feed rate to feed the SAG mill (31-MILS-001). The fresh ore will mix with feed water in the mill feed hopper to achieve the required 75 % solids concentration for optimum milling efficiency. The mill feed dilution water will be ratio controlled to the mill feed rate using the SAG mill feed weightometer and the output from the magnetic flowmeter to control the actuated flow control valve on the process water addition line. The ratio control constant can be adjusted from the relevant supervisory control and data acquisition (SCADA) screen to account for varying ore moistures. The 5.50 m inner diameter and 2.90 m long SAG mill will have a grate discharge with 60 mm apertures. The mill will be driven by a variable speed high voltage motor rated at 1 500 kW through a reduction gearbox, pinion shaft and girth gear, and will rotate between 60 % and 80 % of critical speed for optimum milling efficiency.

The SAG mill discharge will flow through the SAG mill trommel screen (31-TRSC-001). The trommel screen will have polyurethane panels to protect the pumps and cyclones from oversize scats. The trommel screen oversize will be collected in a bunker (31-BNKR-001). The trommel screen undersize will gravitate to the mill discharge sump (31-TKDS-001), where it will be diluted before being fed to the cyclone cluster (31-CYCL-001) by one of the two cyclone feed pumps (31-PMPC-001/002). The slurry pumps will be fitted with variable speed drives and a gland seal water supply system.

Only 67 % of the available cyclones in the cluster will be utilised at normal operating conditions. Cyclone underflow will gravitate to the ball mill (31-MILB-001) feed chute via a velocity breaker (31-TKBX-001) lined with mill balls.

A provision will be made, by installing a three-way splitter box (31-TKBX-001), to direct the cyclone underflow to the SAG mill and also to direct a portion of the underflow to a gravity circuit should it be required in the future.

Cyclone overflow, at 45 % solids by weight and a grind of 80 % passing 75 µm, will gravitate to the trash screen (35-SCRN-001).

The milling area will be bunded to contain spillage, which will gravitate to the spillage pumps, one on the mill feed side (31-PMPV-001) and one on the discharge side (31-PMPV-002), from where it will be pumped to the mill discharge sump (31-TKDS-01).

A tower crane (31-CRAN-001) will be situated between the milling area and the CIL circuit to assist with maintenance, addition of grinding media to the mill, and the lifting of interstage screens in the CIL area. Balls will be loaded into the ball loading hopper (31-BLHP-001) and lifted by the crane to the mill feed chute. They will then be discharged into the mill by lowering the hopper to its rest position.

6.2.4 Trash Handling

Cyclone overflow will gravitate from the cyclone overflow launder to a vibrating trash screen (35-SCRN-001). The trash screen will remove misplaced oversize particles and any trash material (such as vegetal debris, plastic fragments, fuses and copper wires) from the overflow stream prior to downstream processing. Organic trash must be removed from the CIL feed since it has the potential for preg-robbing for gold.

The feed slurry will be distributed over the screen and will drain through into the underpan, from where it will gravitate to the leach feed splitter box (41-TKBX-001). Trash material retained by the screen will be discharged into an oversize screen basket (35-BSKT-001) located in the bund area prior to being transferred to a designated disposal area. Any spillage from the basket will gravitate to the CIL spillage bund, from where it will be pumped, together with the other spillage in the leach area, using a spillage pump (41-PMPV-007) to the leach feed splitter box.

6.2.5 CIL Plant

Feed slurry from the trash screen underpan will gravitate into the leach feed splitter box (41-TKBX-001) and will be transferred into CIL tank 1 or 2 (41-TKFO-001/002).

The CIL section will consist of six tanks (41-TKFO-001 to 006), giving a total residence time of 24 hours to ensure complete dissolution of the gold and its subsequent adsorption onto activated carbon. The slurry and carbon particles in the CIL tanks will be maintained in suspension and agitated by the action of dual impeller mixers (41-MIXR-001 to 006).

Flow of slurry from one CIL tank to another will be through an interconnecting launder system. As the CIL process will be continuous in nature, provision will be made in the design for easy isolation and bypassing of each tank in the event of major equipment breakdown (e.g. agitator, interstage screen, and tank sanding). Each tank outlet launder will be fitted with two dart valves. The first dart valve feeding the next tank in line will normally be open and the second dart valve will connect to the bypass launder and will normally be in a closed position.

Each CIL tank will be equipped with one pumping interstage wedge wire cylindrical screen (41-INSC-001 to 006), which will prevent any migration of carbon from one tank to another. The interstage wedge wire cylindrical screen will peg with near-size carbon and periodically one interstage screen will need to be lifted from the respective tank onto a screen wash frame for cleaning. A spare screen will be provided with a dedicated interstage screen wash frame to replace screens during clean-up or maintenance operations. A high pressure low volume wash pump will be provided to clean blocked screens.

Air will be fed through lances into the bottom section of the first four CIL tanks and dispensed into the slurry ensuring maximum dispersion throughout the pulp. All six CIL tanks will be equipped with air addition lances that can be used when required.

Cyanide solution will be pumped through a ring main, from which it will be dosed into the first CIL tanks. In the event that the determined concentrations are low, addition to downstream CIL tanks will also be done.

Lime slurry will be added from the ring main to the leach feed splitter box (41-TKBX-001) for pH adjustment. A provision will be made to add lime slurry to the first five CIL tanks in the event that the pH values in CIL tank 1 (41-TKFO-001), determined by the pH meter, are low.

Loaded carbon in the CIL slurry will be pumped using the loaded carbon transfer pump (41-PMPV-001) onto the loaded carbon screen (41-SCRN-001). When CIL tank 1 is offline, the loaded carbon transfer pump will be moved to CIL tank 2. The slurry will return as screen undersize to either CIL tank 1 or 2. Spray water will be applied on the loaded carbon screen oversize to ensure that the clean carbon is discharged as screen oversize product into the acid wash cone (61-TKCC-001). Airlifts (41-AILP-001 to 005) will be installed in CIL tanks 2 to 6, respectively to transfer carbon upstream at intermittent intervals. Regenerated or eluted carbon will be added to the last CIL tank or to CIL tank 5 if the last tank is offline.

Pulp from the last CIL tank will gravitate to the detoxification section of the plant.

Spillage in the CIL area will be contained in a bund that will have two spillage pumps (41-PMPV-007 and 41-PMPV-008). The first spillage pump will pump spillage to the leach feed splitter box while the second spillage pump will pump to CIL tank 4.

Two safety showers (41-SASH-001and 002) will be installed for any emergency situations that may arise.

6.2.6 Cyanide Detoxification

The CIL tailings detoxification section will consist of

- A carbon safety screen (51-SCRN-001)
- A single-stage detoxification tank (51-TKFO-001)
- A tailings tank (51-TKDS-001)
- Tailings storage facility (TSF) feed pumps (51-PMPC-001/002)

CIL slurry tails will gravitate to the carbon safety screen (51-SCRN-001) for the recovery of any escaped carbon from the CIL due to damaged interstage screen wedge wire. The carbon safety screen oversize will gravitate into the tails oversize carbon basket (51-BSKT-001). Periodically, the carbon basket will be lifted using the tower crane and its contents will either be emptied into the last CIL tank by opening the trapdoor or they will be bagged and removed from site.

Dilution water will be added to the screen to dilute the slurry from a density of approximately 43 % to 40 % solids by weight. The carbon safety screen underflow will gravitate into the detoxification tank (51-TKFO-001). The overflow from the detoxification tank will again gravitate into the tailings tank (51-TKDS-001).

The free cyanide and/or weakly bound metal cyanide complexes present in the tailings slurry will be oxidised to cyanide by the addition of sulphur dioxide and oxygen according to the following reaction:

$$CN^{-}_{WAD} + SO_2 + O_2 + H_2O = OCN^{-} + H_2SO_4$$

Sulphur dioxide will be supplied in liquid form as sodium metabisulphite via air sparging. The reaction will result in the formation of sulphuric acid; hence lime slurry will be added to maintain an optimal pH range of 8 to 10. The detoxification reaction using this method requires the presence of a copper catalyst at concentrations of approximately 50 mg/L, which will be added to the circuit as copper sulphate solution.

The detoxification circuit will give a total residence time of 1 h. Sodium metabisulphite and copper sulphate will be added to the detoxification tank. Compressed air, for oxygen supply, will be fed to the agitator shafts of the detoxification tank and will be dispensed at the bottom of the shaft to ensure maximum dispersion throughout the pulp. The pulp will then gravitate via an automated sampler (for process accounting and control) into the tailings tank (51-TKDS-001), from where the final tails will be transferred to the TSF.

Spillage in the detoxification area will be contained in a bund fitted with a dedicated spillage pump (51-PMPV-001). Spillage will be pumped back to the tails screen feed box.

A safety shower (51-SASH-001) will be installed for any emergency situations that may arise.

6.2.7 Tailings Disposal and Return Water

Tailings slurry will be transferred from the tailings tank to the TSF. Return water from the TSF will be pumped into the process water tank (84-TKFO-001) and then back into the process plant.

6.2.8 Acid Wash

Loaded carbon will be discharged from the carbon screen directly into the acid wash cone (61-TKCC-01).

The carbon batch will be back-washed with raw water to remove any light trash such as slimes, plastic and organic trash captured in the bed. The raw water flow rate will be sufficient to expand the carbon bed and remove the fines and light tramp materials without losing the larger and heavier carbon particles. The trash will be flushed to the tailings tank (51-TKDS-001) via a gravity pipeline by manipulation of the relevant valves. This operation will normally take approximately 20 min.

Once a batch of carbon has been back-washed, it will be acid washed with dilute hydrochloric acid. Dilute acid solution will be pumped through the carbon bed in the acid wash cone, in closed circuit with the acid wash tank (61-TKFC-001), using the acid wash pump (61-PMPC-001). It may be necessary to increase the acid strength in the event that carbon fouling is very heavy.

The carbon bed will expand during the circulation of dilute acid and this will enable optimum contact between the carbon particles' surfaces and the slow-flowing acid solution. The duration of the acid wash operation will depend on the severity of the scaling taking place at the mine and will be determined by optimisation testwork. The acid wash cone will be emptied to the acid wash tank at the end of the operation.

The residual acid and all traces of chlorides will be removed by rinsing the carbon bed with raw water. It is important to remove chlorides from the carbon prior to stripping because the chlorides tend to form aurocyanide precipitates at high temperatures during stripping, thereby reducing the stripping efficiency. The water rinse stage is therefore very important. The acid neutralisation effluent will be routed to the tailings tank.

The neutralisation of spent acid step is critical for safety reasons and should always be performed diligently to avoid possible hydrogen cyanide gas emissions at the start of the elution cycle.

A bed volume of acid solution will remain in the acid wash cone at the end of each acid wash cycle before the rinsing. Immediate start of the rinsing cycle would send the acid solution to the final tailings tank which may result in the formation of hydrocyanic gas at contact with the cyanide containing tailings. To reduce the possibility of sending acid to the tailings, the bed volume of the acid remaining in the acid wash cone must be washed back into the tank before the rinse effluent is sent to the tailings tank.

A safety shower (51-SASH-001) will be installed for any emergency situations that may arise. Acid solution escaping the acid wash column through the bursting disc will be directed into the acid overflow pot (61-POT-001).
An acid wash spillage pump (61-PMPV-01) will be installed in the acid wash area. Acidic spillage will be pumped to the carbon safety screen feed box.

6.2.9 Elution

Pressurised Zadra will be used as the elution method. Acid-washed carbon will be transferred from the acid wash cone (61-TKCC-001) into the elution column (62-COLM-001) at the end of the acid wash cycle.

A cyanide-caustic solution will be pumped at a flow rate of two bed volumes per hour through the elution column (62-COLM-001) in closed circuit with the eluant tank (62-TKFC-001) whilst being heated up via the secondary and primary heat exchangers (62-HEXR-001/002). The pregnant solution leaving the elution column will be directed to the electrowinning cells flash/cell feed tank (63-TKFC-001) only when the temperature exiting the column outlet reaches 125 °C. The spent electrolyte from electrowinning will flow back to the eluant tank, from where it will be pumped back to the elution column.

The column will be operated under a pressure of typically 300 kPa to 350 kPa. The solution exiting the column will pass through the reclaim heat exchanger to cool the hot eluate to below boiling point and preheat eluant entering the column.

At the end of the elution cycle, the stripped carbon will be hydraulically transferred to the regeneration section and the system will be made available to treat the next batch of loaded carbon.

The eluant exiting the reclaim heat exchanger will be heated to the required temperature of 130 °C by thermic oil in the primary heat exchanger prior to entering the column. The electric elution heaters (62-HETR-001/002/003) will heat up the thermic oil and then the thermic oil will be circulated through the primary heat exchanger (62-HEXR-001), where it will transfer the heat to the eluant.

The elution cycle will run for approximately 14 h; this period could be shorter or longer depending on the loaded carbon value. At the end of the cycle, the column contents will be cooled for a further 2 h by switching off the thermic oil heaters and allowing the eluant to circulate until a cool down temperature of 90 °C is achieved, at which time the column will be ready for emptying. Eluted carbon will then be hydraulically transferred to the regenerated carbon holding tank (64-TKSO-001).

The eluant solution will be re-used for a number of elutions, typically four, until the level of contamination becomes unacceptable. The spent eluant will be drained from the eluant tank and directed into a spillage bund area, from where it will be pumped to the CIL. A fresh eluant batch will then be prepared by adding raw water, 25 % sodium cyanide solution and 20 % caustic soda solution to get 2 % NaCN and 3 % NaOH.

Due to the use of caustic and cyanide in this area, safety showers (62-SASH-001/002) will be provided. They will be activated by a foot pedal and equipped with an eye bath.

Spillage in the elution area will be contained in a bund that has a spillage pump (62-PMPV-001), which will pump spillage to the CIL circuit.

Two safety showers (62-SASH-001 and 002) will be installed for any emergency situations that may arise.

6.2.10 Carbon Regeneration

Eluted carbon will be transferred hydraulically from the elution column to the eluted carbon holding tank (64-TKSO-001). When the regeneration kiln is unavailable, eluted carbon will be transferred directly to the CIL plant by repositioning two manually operated valves.

During the transfer operation to the eluted carbon holding tank, excess water and fine carbon particles will overflow from the tank through strainers and will gravitate to the tailings tank (51-TKDS-001). Carbon will be withdrawn from the eluted carbon tank by a screw feeder, which will discharge the carbon to an electrical rotary kiln (64-REGN-001) for thermal regeneration. Regenerated carbon will be quenched with raw water in the quench pan before it can react with atmospheric oxygen. Quenched carbon will be passed over a screen (64-SCRN-001) to remove fines, before the carbon gravitates to the last CIL tank. The fines will be discarded as screen undersize to the cyanide detoxification circuit for disposal.

Since the regeneration circuit is located above the CIL circuit, no dedicated spillage pump is provided.

6.2.11 Electrowinning and Cathode Wash

There will be two single electrowinning cells for treating the pregnant solution from CIL. The eluate from the elution column will be directed to the CIL electrowinning cell feed tank. From the cell feed tank, electrolyte will be distributed to the two electrowinning (EW) cells (63-EWCL-001/002). Excess solution in the cell feed tank will overflow, bypass the EW cell, and join the cell outlet solution to the return pipe, which will direct it back to the eluant tank.

Gold will be electrowon from the eluate solution by using sludging-type stainless steel mesh cathodes. Gold will be plated as loosely and finely divided sludge that will adhere onto the pad of stainless steel knit mesh contained in the cathode basket. The operation of electrowinning in closed circuit with elution will take 14 h. The cycle time will vary according to the carbon loadings.

Once an electrowinning batch is complete, i.e. the gold grade of the solution has been reduced to a stipulated level, the barren electrolyte will be pumped to the CIL feed splitter box.

One electrowinning cathode hoist (63-HYST-001) will be provided to remove loaded cathodes periodically and lower them into the cathode wash tank (63-TKSO-001). The cathode wash pump (63-PMPW-001) will provide a high pressure water spray to remove the sludge adhering to the cathode mesh. The gold sludge will be collected in the gold sludge tank (63-TKSC-001), from where it will be manually transferred into a bucket and taken to a batch-type pot filter for dewatering. The filter cake (dewatered sludge) will be packed into trays and placed in the calcining oven (65-CALO-001) in the gold room for drying. The filtration of the sludge is a manual operation normally carried out during the day shift.

A fume extraction system will be installed to collect potentially poisonous and explosive gases that evolve during electrowinning from the cells. The fume extraction fan discharges through the gold room roof to the atmosphere.

Pregnant solution spillage from the electrowinning cells will be directed to a sump from where it will be pumped back into the gold sludge tank (63-TKSC-001).

Two safety showers (63-SASH-001/002) will be provided, one dedicated to the electrowinning area and one to the gold sludge area.

A hydrogen cyanide gas detector will be installed in the EW circuit with SCADA indication. High levels of hydrogen cyanide gas will trigger an alarm on the SCADA system and a siren will sound in the EW area.

6.2.12 Gold Room

The dewatered sludge obtained from the pot filter will be spread evenly over the area of the trays to provide even drying over the whole surface. Great care shall be exercised in handling the sludge to avoid any spillage as this material is of smeltable grade.

Trays will be loaded manually into the calcining oven (65-CALO-001), which will be fitted with a timer and a temperature control system. Hot gases from the oven will be vented to the outside of the gold room. Compressed air can be injected into the flue duct to create a Venturi effect and assist with hot air extraction.

The dried sludge, once cooled, will be mixed with fluxes stored in a storage box (65-TKBX-001) in pre-determined proportions. The gold sludge/flux mix will then be transferred to a smelting crucible, which in turn will be placed in the induction smelting furnace which will operate at 1 200 °C to 1 400 °C. Gold melts at 1 063 °C.

The smelting furnace (65-SMFU-001) will be charged manually and started locally. It will be fitted with temperature control and a tilting motor. The smelting furnace will be covered by a fume hood with a flue duct connected to an extraction fan (65-FAN-001).

Furnace cooling will be achieved by circulating cold water through the furnace jacket and out to the cooling tower before pumping it back to the furnace.

At the completion of a smelt, the molten furnace charge will be poured into cascading bullion moulds, mounted on a cascading trolley. The bullion will collect in the first mould with any excess collected in the second mould, whilst slag will flow and collect in a slag-collecting crucible. The heavy metallic phase will sink to the bottom of the moulds, whilst the light slag phase will float on top of the metallic phase. When both phases cool and solidify, the glassy slag phase will be easily broken away from the metallic phase, leaving a relatively pure gold bar.

The doré bar, once cooled, will be cleaned by hammering to remove any traces of adhering slag, then sampled, labelled and weighed. Gold bars will then be stored in a safe prior to dispatch to the refinery.

Top-loading electronic scales will be used for weighing the gold bars and for flux formulation. An analytical electronic scale will be used for weighing gold samples extracted from the gold bars by means of an electric drill.

Fresh air will be forced through the gold room by means of a ventilation system (65-VENT-001).

6.2.13 Services

6.2.13.1 Compressed Air

The compressors (one duty and one standby) will be situated inside the plant area. Two high pressure compressors (81-COMP-001 and 002) will be dedicated to supplying plant air and instrument air to the plant. Plant air will be stored in a dedicated receiver (81-RECV-001), from where it will be distributed to the plant and workshop. A portion of the air from the duty high pressure compressor will be filtered and dried in a refrigerant-type dryer (81-ADRY-001). Dried air will be filtered again and stored in an instrument air receiver (81-RECV-002), from where it will be distributed to all the relevant instruments throughout the plant.

Two low pressure compressors (81-COMP-003 and 004) in a duty/standby arrangement will provide low pressure air to the CIL circuit for oxidation and airlifts, and also to the cyanide detoxification circuit for oxidation.

6.2.13.2 Water Circuits

6.2.13.2.1 Process Water Circuit

A 1 000 m^3 process water tank (84-TKFO-001) will be fed with return water from the TSF. Top-up water will be pumped from the raw water abstraction dam to the process water tank to make up the process water requirements in the plant.

Process water pumps (84-PMPC-001/002) will distribute process water to the milling, detoxification and lime make-up circuits. The spray water pumps (84-PMPC-03/004) will supply spray water around the plant, and a dedicated hosing water pump (84-PMPC-005) will supply hosing water to the plant.

Spillage in the area will be contained in a bund and pumped back into the process water tank via a spillage pump (84-PMPV-001).

6.2.13.2.2 Raw Water Circuit

The process plant raw water requirement will be supplied from the raw water dam located outside the process plant area. Raw water will be pumped from the raw water dam to a 500 m^3 raw water tank at the process plant.

A carbon transfer pump (85-PMPC-001) will provide water for transferring eluted carbon from the elution column to the regeneration facility.

Gland water pumps (85-PMPC-002/003) will supply gland seal water to the cyclone feed pumps in the milling circuit and the final tails pumps.

Raw water pumps (85-PMPC-004/005) will distribute raw water to the crushing and stockpile area for dust suppression, to the milling circuit for SAG and ball mill cooling requirements, to the CIL for interstage screen wash, to acid wash, to elution, to regeneration for quenching of carbon, to electrowinning for cathode wash, to the smelting furnace cooling system, for reagents make-up, and to the water treatment plant.

Two pumps (85-PMPC-006/007), one electric and the other diesel powered, will be dedicated to the fire reticulation water system. The diesel-powered pump will only be used in the event of a fire that has affected the power supply to the plant; resulting in the unavailability of the electric fire water pump. A jockey pump (85-PMPJ-001) will maintain the required pressure in the fire water header.

6.2.13.2.3 Potable Water Circuit

Raw water is treated in the potable water treatment plant (85-WATP-001), from where it will be pumped to the potable water storage tank (85-TKFC-001). Potable water pumps (85-PMPC-008/009) will pump potable water to the safety shower water tank and the hydrosphere. The safety shower water tank will distribute potable water to all the safety showers in the process plant. The hydrosphere, while maintaining the desired pressure in the potable water header, will distribute potable water for consumption and ablution to the offices, workshop, laboratory, etc.

6.2.14 Reagents

6.2.14.1 Cyanide

Cyanide solution will be made up once per day. It will be made up as a 25 % solution by mass in the cyanide mixing tank (71-TKFC-001).

The cyanide mixing tank will be a split-type tank which will act as both a make-up and dosing tank. This will allow the cyanide solution to be made up in the one section and then overflow into the other, smaller section. Cyanide can be pumped from the smaller section, which will provide sufficient residence time to make up another batch of cyanide in the mixing side.

To make up a batch of cyanide, the immediate area will be barricaded using a chain and a "Cyanide Make-up in Progress" safety sign will be displayed. The required number of 1 t bulk bags will be transported from the stores and lifted into position above the cyanide mixing tank inlet hopper using an electric hoist (71-HYST-001). The cyanide mixing tank will be filled to a pre-determined level with clean raw water. The covered tank will be fitted with an agitator (71-MIXR-001) which will ensure sufficient mixing in the tank. The cyanide bulk bags will be torn open, one at a time, using a bag breaker (71-BBRK-001), and the briquettes will be discharged into the mixing tank via a feed hopper, which mixes with the raw water to produce a 25 % NaCN solution. Total dissolution will normally be achieved after approximately 1 h.

Cyanide dosing using pumps (71-PMPP-001/002) to the CIL, elution and electrowinning will be via the ring main and flow control valves. Cyanide solution spillage will be collected within the bund of the floor sump and will either be pumped to the cyanide mixing tank or the CIL feed box by the cyanide spillage pump (71-PMPV-001).

A safety shower (71-SASH-001) will be installed in the area for any emergency situations that may arise.

6.2.14.2 Caustic Soda (Sodium Hydroxide)

Strong caustic solutions will be prepared by mixing sodium hydroxide pearls (approximately 5 mm granules) with clean raw water in a tank fitted with an agitator.

The required number of 25 kg caustic soda bags will be transported from the stores, lifted with the electric hoist (71-HYST-001), and placed on the walkway next to the caustic tank feed hopper. The caustic tank (71-TKFC-002) will be filled with clean raw water to a pre-determined level. The covered tank will be fitted with an agitator (71-MIXR-002). The caustic soda bags will be torn open, one at a time, using a bag breaker (71-BBRK-002), and the pearls will be slowly fed to the agitated water via the feed hopper to produce a 20 % NaOH solution. Total dissolution will normally be achieved after 30 min.

The tank will also serve as a caustic soda solution storage tank, with intermittent dosing to the elution/electrowinning, intense leach, cyanide make-up and acid wash areas, directly from the tank using the caustic dosing pump (71-PMPC-001).

Caustic spillage from the caustic tank bunded area flows onto the cyanide bunded floor to the spillage pump (71-PMPV-001).

A safety shower (71-SASH-002) will be installed in the area for any emergency situations that may arise.

6.2.14.3 Lime

The required number of 1 t lime bags will be transported from the stores, lifted with the electric hoist (72-HYST-001), and placed on the walkway next to the lime tank feed hopper. The lime mixing tank (72-TKFC-001) will be filled with clean raw water to a pre-determined level. The covered tank will be fitted with an agitator (72-MIXR-001). The lime bags will be torn open, one at a time, using a bag breaker (72-BBRK-001), and the powder will be slowly fed to the agitated water via the feed hopper to produce a 20 % lime slurry. After total dissolution is achieved, the lime slurry will be pumped by the lime transfer pump (72-PMPC-001) to the lime storage and dosing tank (72-TKFO-001). The tank will be equipped with an agitator (72-MIXR-002), which will ensure that the lime slurry will be adequately suspended in the storage and dosing tank.

Lime slurry will be pumped through a ring main by the lime dosing pump (72-PMPC-002/003) with branches to the mill feed hopper, leach feed splitter box, detoxification tank and, if required, to the tailings tank. Unused lime slurry will be returned to the dosing tank from the ring main.

A safety shower (72-SASH-001) will be provided in the lime area. The safety shower will be activated by a foot pedal and will be equipped with an eye bath.

Spillage generated in the lime area will be pumped by the lime spillage pump 1 (72-PMPV-001) to the make-up tank.

6.2.14.4 Copper Sulphate

Copper sulphate solution will be made up once per day. It will be made up as a 15 % solution by mass in the copper sulphate mixing tank (74-TKFC-001).

The required number of 25 kg bags will be transported from the stores and lifted into position above the copper sulphate mixing tank (74-TKFC-001) inlet hopper using an electric hoist (74-HYST-001). The copper sulphate mixing tank will be filled to a pre-determined level with raw water. The covered tank will be fitted with an agitator (74-MIXR-001), which will ensure sufficient mixing in the tank. The bulk bags will be torn open, one at a time, using a bag breaker (74-BBRK-001), and the crystals will be discharged into the hopper basket, from where they will fall into the raw water and dissolve. Total dissolution will normally be achieved after approximately 1 h.

Once dissolved, the solution will be dosed via one of two variable speed pumps (74-PMPP-001/002).

Copper sulphate solution spillage will be collected within the bund of the floor sump and will be pumped to the detoxification tank (51-TKFO-001) by the copper sulphate spillage pump (74-PMPV-001).

6.2.14.5 Sodium Metabisulphite

Sodium metabisulphite solution will be made up once per day. It will be made up as a 25 % solution by mass in the sodium metabisulphite mixing tank (74-TKFC-03).

The required number of 25 kg bags will be transported from the stores and lifted into position above the sodium metabisulphite mixing tank (74-TKFC-002) inlet hopper using an electric hoist (74-HYST-001). The mixing tank will be filled to a pre-determined level with raw water. The covered tank will be fitted with an agitator (74-MIXR-002), which will ensure sufficient mixing in the tank. The bulk bags will be torn open, one at a time, using a bag breaker (74-BBRK-002), and the crystals will discharge into the hopper basket, from where they will fall into the raw water and dissolve. Total dissolution will normally be achieved after approximately 1 h.

Once dissolved, the solution will be dosed via one of two variable speed pumps (74-PMPP-003/004).

Sodium metabisulphite solution spillage will be collected within the same bund and will be pumped to the detoxification tank (51-TKFO-001) by the copper sulphate spillage pump (74-PMPV-001).

6.3 PROCESS DESIGN CRITERIA

The Tulu Kapi Process Plant will be designed for a throughput of 1.2 Mtpa utilising the proven CIL process technology for the treatment of oxide, softer fresh and hard fresh ore.

The data used in the process design criteria has been derived from various sources:

1. Client (KEFI Minerals)
2. Metallurgical Testwork
3. Calculated Data
4. Vendor Data or Recommendations
5. SENET
6. Industry Standard or Practice
7. Handbook (Engineering Handbook)
8. Assumption based on experience
9. External Consultants:

    - Mining – Snowden
    - Metallurgical Testwork – AMMTEC
    - Comminution Modelling – OMC

Table 6-18 to Table 6-29 provide details of the design criteria used for the process plant.

Table 6-18: Summary of Site Conditions and Electrical Information

Description	Unit	Design	Source
Site Conditions			
Location		Ethiopia	Client
Elevation/Altitude	mASL	1 663	Client
Atmospheric Pressure	kPa	81.7	Calculated
Temperature:			
Minimum Summer	°C	14	Client
Maximum Summer	°C	32	Client
Minimum Winter	°C	13	Client
Maximum Winter	°C	24	Client
Annual Average Rainfall	mm	1 000	Client
Electrical Information			
Voltage Supply	V	400	SENET
Frequency	Hz	50	Client
Voltage Fluctuation	%	7.5 %	Client
Control Voltage	V AC	110	SENET

Table 6-19: Ore Characteristics

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Ore Source		Open Cast	Open Cast	Open Cast	Client
Ore Type		Oxide	Fresh	Harder Fresh	Client
Maximum Lump Size F_{100}	mm	800	800	800	Client
Ore Head Grades:					
Ore Grade - Gold	g/t Au	1.78	2.23	2.86	Client
Ore Grade - Silver	g/t Ag	< 2	1.40	1.40	Testwork
Moisture Content	%	5.0 %	5.0 %	5.0 %	Testwork
Water SG	t/m^3	1.00	1.00	1.00	Testwork
Water Source		Rainfall	Rainfall	Rainfall	Client
Specific Gravity	t/m^3	2.74	2.83	2.83	Testwork
Bulk Density of Crushed Ore	t/m^3	1.64	1.70	1.70	Calculated
Angle of Repose	°	35°	35°	35°	SENET
Angle of Surcharge	°	20°	20°	20°	SENET
Angle of Withdrawal	°	60°	60°	60°	SENET
Unconfined Compressive Strength	MPa	N/A	N/A	N/A	
Bond Crusher Work Index	kWh/t	8.2	11.4	12.9	Testwork
Bond Rod Mill Work Index	kWh/t	11.3	12.2	19.7	Testwork
Bond Ball Mill Work Index	kWh/t	15.5	15.5	18.0	Testwork
Abrasion Index		0.314	0.390	0.652	Testwork
JK Tech Parameters:					
A		67.4	66.5	70.2	Testwork
b		1.66	1.23	0.55	Testwork
A × b		112	82	39	Calculated
T_a		1.14	0.72	0.29	Testwork

Table 6-20: Operating Schedule

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
General					
Ore Reserves	Mt	0.9	10.1	4.4	Client
Annual Tonnage Treated	Mtpa	1.20	1.20	1.20	Client
Crushing					
Days per Year	d	365	365	365	Client
Days per Week	d	7	7	7	Client
Hours per Day	h	24	24	24	Client
Maintenance	h/week	8	8	8	Industry Practice
Utilisation	%	67 %	67 %	67 %	Industry Practice
Availability	%	96 %	96 %	96 %	Client

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Milling					
Scheduled Operating Days per Annum	d	365	365	365	Client
Days per Week	d	7	7	7	Client
Hours per Day	h	24	24	24	Client
Scheduled Maintenance per Week	h	6	6	6	Industry Practice
Number of Mill Relines per Annum		2	2	2	Industry Practice
Time Required per Mill Reline	h	36	36	36	Industry Practice
Availability	%	96 %	96 %	96 %	Client

Table 6-21: Crushing and Ore Stockpile

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Primary Crushing					
Number of Primary Crushing Circuits		1	1	1	Client
ROM Oversize Handling	mm	Rock breaker	Rock breaker	Rock breaker	Client
Maximum Lump Size	mm	800	800	800	OMC
Required Final Crushing Product Size P_{80}	mm	125	125	125	OMC
Crusher Product Size P_{100}	mm	220	220	220	OMC
Feeding of ROM Bin Method		Truck	Truck	Truck	Client
Truck Load Size	t	100	100	100	Client
ROM Bin Capacity	m^3	70	70	70	SENET
Crusher Type		Jaw	Jaw	Jaw	SENET/Client
Withdrawal Method From Bin		APRF	APRF	APRF	SENET/Client
Secondary Crushing (Future)					
Crusher Feed Size P_{80}	mm	-	-	125	OMC
Crusher Feed Size P_{100}	mm	-	-	220	OMC
Required Crusher Product Size P_{80}	mm	-	-	42	OMC
Crusher Product Size P_{100}	mm	-	-	58	OMC
Crusher Type		-	-	Cone	SENET/Client
Secondary Screen (Future)					
Type of Screen		-	-	Vibrating	SENET/Client
Top Deck Aperture Size		-	-	125 Square	Supplier
Bottom Deck Aperture Size		-	-	32 Slotted	SENET
Screen Undersize P_{80}		-	-	25	OMC
Screen Undersize P_{100}		-	-	32	OMC
Mill Feed Stockpile					
Number of Stockpiles		1	1	1	SENET/Client
Stockpile Live Capacity	d	1	1	1	SENET
Stockpile Live Capacity	t	3 600	3 600	3 600	Calculated
Withdrawal Method from Stockpile		Pan Feeder	Pan Feeder	Pan Feeder	SENET
Number of Feeders		3	3	3	SENET/Client

Table 6-22: Grinding and Classification

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Milling Circuit Selection					
Circuit Type		SAB	SAB	SAB	SENET/Client
Circuit Description		SAG and Ball Mill	SAG and Ball Mill	SAG and Ball Mill	SENET/Client
SAG Milling					
Number of Mills		1	1	1	OMC
Wet or Dry Milling		Wet	Wet	Wet	Industry Practice
Open or Closed Circuit		Closed	Closed	Closed	Industry Practice
Overflow or Grate		Grate	Grate	Grate	Industry Practice
Product Size Control $D_{50,60,70,80,90,92,95}$		80	80	80	Industry Practice
Feed Size (F_{80})	mm	125	125	125	Testwork
Product Size (P_{80})	µm	75	75	75	Testwork
Discharge Slurry % Solids from Mill	%	75 %	75 %	75 %	OMC
SAG Mill Ball Load (Maximum)	%	15 %	15 %	18 %	OMC
SAG Mill Total Load (Maximum)	%	25 %	25 %	20 %	OMC
Selected Grinding Ball Size	mm	125	125	125	OMC
Ball Material (High Cr, Cast or Forged)		High Cr	High Cr	High Cr	SENET/Client
Ball Milling					
Number of Mills		1	1	1	SENET/Client
Wet or Dry Milling		Wet	Wet	Wet	Industry Practice
Open or Closed Circuit		Closed	Closed	Closed	Industry Practice
Overflow or Grate		Overflow	Overflow	Overflow	Industry Practice
Product Size Control $D_{50,60,70,80,90,92,95}$		80	80	80	Industry Practice
Feed Size (F_{80})	mm	2	2	2	OMC
Product Size (P_{80})	µm	75	75	75	Client
Discharge Slurry % Solids from Mill	%	70 %	70 %	70 %	Industry Practice
Ball Charge (Maximum)	%	36 %	36 %	36 %	Testwork
Selected Grinding Ball Size	mm	50	50	50	OMC
Ball Material (High Cr, Cast or Forged)		High Cr	High Cr	High Cr	SENET/Client
Classification					
Mill Discharge Sump					
Number of Mill Sumps		1	1	1	SENET/Client
Residence Time	min	2.0	2.0	2.0	SENET
Classification					
Type of Classification		Cluster	Cluster	Cluster	SENET/Client
Number of Clusters		1	1	1	SENET/Client
% Standby Cyclones	%	25 % - 30 %	25 % - 30 %	25 % - 30 %	SENET/Client
% Solids in Cyclone Overflow	%	45 %	45 %	45 %	Client
% Solids in Cyclone Underflow	%	70 %	70 %	70 %	Industry Practice
Operating Circulating Load	%	250 %	250 %	250 %	Industry Practice
Design Circulating Load	%	350 %	350 %	350 %	Industry Practice

Table 6-23: Trash Handling Screen

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Type of Screen		Vibrating	Vibrating	Vibrating	SENET/Client
Aperture Size	mm	0.630 × 8.8	0.630 × 8.8	0.630 × 8.8	SENET/Supplier
Underflow Slurry Transport Method		Gravity	Gravity	Gravity	SENET

Table 6-24: Carbon in Leach

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Leach Circuit					
Type of Leach Circuit		CIL	CIL	CIL	SENET/Client
Leach Solids Feed %	% m/m	45 %	45 %	45 %	Testwork/SENET
Leach Feed Grade (Au)	g/t head feed	1.78	2.23	2.86	Client
Leach Dissolution (Au)	%	97.0 %	95.3 %	96.2 %	Calculated
Confidence Level on Dissolution	%	99 %	99 %	99 %	Estimated
CIL Solution Tails	ppm	0.015	0.015	0.015	Industry Practice
CIL Tank Residence Time	h	24.0	24.0	24.0	Testwork
Carbon Concentration	g/L	12	12	12	Client/SENET
Barren Carbon Loading (Au)	g/t	1 100	1 100	800	Industry Practice
Oxygen or Air Supply					
Oxygen or air		Air	Air	Air	Testwork
Method of Air Addition to Circuit		Sparging into Tank	Sparging into Tank	Sparging into Tank	Client
Interstage Screen					
Interstage Screen Type		MPS (P)	MPS (P)	MPS (P)	SENET
Aperture Size	µm	800	800	800	SENET
Intertank Flow					
Slurry Flow		Pumping Screens	Pumping Screens	Pumping Screens	SENET
Loaded Carbon Transfer		Airlifts	Airlifts	Airlifts	SENET/Client
Intertank Carbon Transfer		Recessed Impeller Pump	Recessed Impeller Pump	Recessed Impeller Pump	SENET
Loaded Carbon Screen					
Type of Screen		Vibrating	Vibrating	Vibrating	SENET/Client
Aperture Size	mm	0.63 × 8.8	0.63 × 8.8	0.63 × 8.8	SENET/Supplier
Carbon Safety Screen					
Type of Screen		Vibrating	Vibrating	Vibrating	SENET/Client
Aperture Size	mm	0.80 × 8.8	0.80 × 8.8	0.80 × 8.8	SENET/Supplier

Table 6-25: Tailings Detoxification

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Cyanide Detoxification					
Detoxification Method		INCO	INCO	INCO	SENET/Client
Required Residence Time	h	1	1	1	Client/Testwork
Number of Tanks		1	1	1	Client
Cyanide in Final Detoxification Tails	ppm	50 WAD	50 WAD	50 WAD	Industry Practice
Final Tailings Tank					
Required Residence Time	min	2	2	2	SENET

Table 6-26: Acid Wash, Elution and Regeneration

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Acid Wash					
Type of Acid Wash Vessel		Conical Tank	Conical Tank	Conical Tank	SENET/Client
Material of Construction		FRP	FRP	FRP	SENET/Client
Flow Through the Vessel	BV/h	2.0	2.0	2.0	Industry Practice
Acid Wash Time	h	1.0	1.0	1.0	Industry Practice
Acid Wash every Number of Elutions		1.0	1.0	1.0	Industry Practice
Operating Temperature	°C	Ambient	Ambient	Ambient	Industry Practice
Acid Wash Tank					
Minimum Acid Wash Mixing Tank Volume	BV	1.0	1.0	1.0	Industry Practice
Acid Wash Time per Recirculation	h	1.0	1.0	1.0	Industry Practice
Acid Wash Solution Strength - HCl	%	3.0 %	3.0 %	3.0 %	Industry Practice
Rinsing					
Rinse Volume	BV/h	2.0	2.0	2.0	Industry Practice
Rinse Time	h	2.0	2.0	2.0	Industry Practice
Cone-Emptying Method		Gravity	Gravity	Gravity	Industry Practice
Elution					
Elution Method		Zadra	Zadra	Zadra	SENET/Client
Material of Construction		304SS	304SS	304SS	SENET/Client
Operating Temperature	°C	120	120	120	Industry Practice
Design Temperature	°C	140	140	140	SENET/Client
Operating Pressure	kPa	350	350	350	Industry Practice
Carbon Transfer Method		Hydraulic	Hydraulic	Hydraulic	SENET
Number of Elutions per Day - Design		1	1	1	SENET
Number of Elutions per Month - Design		29	30	30	Calculated
Design Barren Carbon Loading	g/t	50	50	50	SENET/Client
Flow Through the Column	BV/h	2	2	2	Industry Practice
Eluant Tank					
Minimum Eluant Tank Volume	BV	1.0	1.0	1.0	Industry Practice
Cyanide Strength in Eluant	%	2.0 %	2.0 %	2.0 %	Industry Practice

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Caustic Strength in Eluant	%	3.0 %	3.0 %	3.0 %	Industry Practice
Elution Heating					
Elution Heating Type		Thermic Oil	Thermic Oil	Thermic Oil	Industry Practice
Elution Heaters Type		Electric	Electric	Electric	Client
Regeneration Feed Hopper					
Method of Dewatering		Strainers	Strainers	Strainers	SENET
Hopper Capacity		1 Strip Batch	1 Strip Batch	1 Strip Batch	SENET
Regeneration Kiln					
Type of Kiln		Horizontal	Horizontal	Horizontal	Client
Type of Kiln Heating		Electric	Electric	Electric	Client
Temperature Control		Automatic	Automatic	Automatic	Client
Regeneration Temperature	°C	700	700	700	SENET/Client
Maximum Operating Temperature	°C	800	800	800	Supplier
Regeneration Kiln Running Time per Day	h	20	20	20	Industry Practice
Carbon Transfer Method		Gravity	Gravity	Gravity	Industry Practice
Regeneration Carbon Screen					
Type of Screen		Vibrating	Vibrating	Vibrating	SENET
Aperture Size	mm	1.0 × 28	1.0 × 28	1.0 × 28	SENET/Supplier

Table 6-27: Electrowinning and Smelting

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Electrowinning					
Flash Tank Residence Time	min	1.5	1.5	1.5	SENET
Cell Type		Atm Sludging	Atm Sludging	Atm Sludging	Supplier
Mode of Cell Operation/Feed		Parallel	Parallel	Parallel	SENET/Client
Time per Electrowinning Batch	h	14	14	14	SENET/Client
Cell Solution Temperature	°C	85	85	85	Industry Practice
Type of Cathode		S/S Mesh	S/S Mesh	S/S Mesh	Industry Practice
Type of Anode		S/S	S/S	S/S	Industry Practice
Barren Solution Grade (Au)	ppm	5.0	5.0	5.0	Industry Practice
Percentage Au Recovery	%	98 %	98 %	98 %	Industry Practice
Cathode Sludge Removal		High Pressure Wash	High Pressure Wash	High Pressure Wash	Industry Practice
Sludge Handling					
Filter Type		Pot Filter	Pot Filter	Pot Filter	Industry Practice
Calcining and Smelting					
Calcine Oven Type		Electric	Electric	Electric	SENET/Client
Smelting Furnace Type		Induction	Induction	Induction	SENET/Client

Table 6-28: Reagents

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Lime					
Delivery Method		Bulk Bags/Trucks	Bulk Bags/Trucks	Bulk Bags/Trucks	Supplier
Delivery Size	kg	1 000	1 000	1 000	Supplier
Physical Form		Powder	Powder	Powder	Client
Type of Lime		Hydrated Lime	Hydrated Lime	Hydrated Lime	Supplier
Equivalent % CaO	% CaO	75 %	75 %	75 %	Supplier
Lime SG	t/m^3	2.24	2.24	2.24	Supplier
Lime Bulk SG	t/m^3	0.65	0.65	0.65	Supplier
Consumption as 100 % - CIL	kg/t head	3.02	0.38	0.39	Testwork
Consumption as 100 % - Detoxification	kg/t head	0.23	0.23	0.23	Testwork
Lime Make-up Solids Content	% m/m	20 %	20 %	20 %	SENET
Number of Make-ups per Day		4	1	1	SENET
Lime Addition Points		CIL and Tailings Tank	CIL and Tailings Tank	CIL and Tailings Tank	SENET/Client
Lime Addition Method		Ring main	Ring main	Ring main	SENET/Client
Sodium Cyanide (NaCN)					
Delivery Method		Box	Box	Box	Supplier
Delivery Size	kg/bag	1 000	1 000	1 000	Supplier
Physical Form		Briquettes	Briquettes	Briquettes	Supplier
CIL Consumption	kg/t head	0.28	0.10	0.13	Testwork
Cyanide Make-up Strength	%	25.0 %	25.0 %	25.0 %	SENET
Make-up Frequency	d	Every 4 d	Every 4 d	Every 4 d	SENET/Client
25 % Cyanide Solution Density	t/m^3	1.13	1.13	1.13	Industry Practice
Make-up Tank Capacity	d	2	2	2	SENET/Client
Dosing Tank Capacity	d	2	2	2	SENET/Client
Caustic Soda (NaOH)					
Delivery Method		Bags	Bags	Bags	Supplier
Delivery Size	kg	25	25	25	Supplier
Physical Form		Pearls	Pearls	Pearls	Supplier
Caustic Addition to Make-up Tank		Manual	Manual	Manual	Manual
Solution Strength	% m/m	20 %	20 %	20 %	Industry Practice
20% Caustic Solution SG	t/m^3	1.24	1.24	1.24	Industry Practice
Make-up every	d	5	5	5	SENET/Client
Hydrochloric Acid (HCl)					
Delivery Method		Drums/IBC	Drums/IBC	Drums/IBC	Supplier
Delivery Size	L	200	200	200	Supplier
Physical Form		Solution	Solution	Solution	Supplier
HCl Delivered Strength	% m/m	33 %	33 %	33 %	Supplier
33 % HCl SG	t/m^3	1.15	1.15	1.15	Supplier
Storage Capacity	d	2	2	2	SENET

Description	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Acid Re-use per number of Acid Wash Batches		2	2	2	SENET
Activated Carbon					
Delivery Method		Bags	Bags	Bags	Supplier
Delivery Size	kg/bag	500	500	500	Supplier
Type of carbon	Mesh	8 × 16	8 × 16	8 × 16	Client/Supplier
Type of carbon	mm	1.68 × 2.38	1.68 × 2.39	1.68 × 2.40	Industry Practice
Carbon Bulk Density	t/m^3	0.45	0.45	0.45	Industry Practice
Carbon Dry SG	t/m^3	0.8	0.8	0.8	Industry Practice
Carbon Wet SG	t/m^3	1.37	1.37	1.37	Industry Practice
Consumption Rate	g/t	25	25	25	Industry Practice
Sodium Metabisulphite ($Na_2S_2O_5$)					
Delivery Method		Bags	Bags	Bags	Supplier
Delivery Size	kg	25	25	25	Supplier
Physical Form		Powder	Powder	Powder	Supplier
Usage Rate per Residual Cyanide	g/g NaCN WAD	5.05	5.05	5.05	Testwork
Residual Cyanide	ppm	137	109	109	Testwork
Cyanide in Detoxed Slurry	ppm	50	50	50	Industry Practice
Mixing Strength	% m/m	25 %	25 %	25 %	Client/Supplier
Holding Tank Capacity	d	1	1	1	Industry Practice
Copper Sulphate ($CuSO_4$)					
Delivery Method		Bags	Bags	Bags	Supplier
Delivery Size	kg	25	25	25	Supplier
Physical Form		Crystals	Crystals	Crystals	Supplier
Usage Rate per Residual Cyanide	g/g NaCN	0.83	0.83	0.83	Testwork
Residual Cyanide	ppm	137	109	109	Testwork
Cyanide in Detoxed Slurry	ppm	50	50	50	Industry Practice
Mixing Strength	% m/m	15 %	15 %	15 %	Client/Supplier
Holding Tank Capacity	d	3	3	3	SENET/Client

Table 6-29: Water Services

Water Services	Unit	Oxide	Shallow Fresh	Deep Fresh	Source
Process Water Pond					
Residence Time	h	4			SENET/Client
Plant Raw Water Pond					
Residence Time	h	4			SENET/Client
Gland Water Storage Tank					
Residence Time	h	3			SENET/Client
Plant Potable Water Storage Tank					
Residence Time	h	12			SENET/Client

6.4 PROCESS CONTROL PHILOSOPHY

6.4.1 Introduction

This section summarises the control elements that will be in place to assist the plant personnel to operate the Tulu Kapi gold plant safely and efficiently.

The programmable logic controller (PLC) and SCADA system will allow a trained Control Room Operator (CRO) to monitor and control all the relevant process operations for the gold producing plant. Some equipment operations will be controlled remotely, but they will also allow a field operator (FO) to stop any equipment in the field, if required.

Equipment protection is considered in every design aspect of the plant in order to ensure efficient running of the plant and maximum life of the operating equipment.

Process continuity maximises production. Continuous measurement of process parameters allows management to monitor the performance of the processing plant.

Health and safety management is one of the most important aspects in any processing environment. Tulu Kapi will comply with the relevant health and safety requirements set forth by the Client and world standards. Taking into account that lifting and moving of equipment or consumables will play an integral role in the day-to-day running of the process plant, Tulu Kapi will utilise lifting equipment only where necessary and with the required precautions in place to minimise any associated risks.

The high commodity value of the final product requires serious security considerations to protect Tulu Kapi against gold theft.

6.4.2 General Control Philosophy

The process plant will operate with a relatively low level of automation. Control will be automated as far as possible to ensure minimal downtime even when there is equipment failure, therefore maximising the running availability of the overall plant. The PLC will provide the necessary logic to the equipment to enable the standby to start automatically from the SCADA system if it is safe to do so.

6.4.2.1 PLC and SCADA

Plant drives and valves considered critical to production will be remotely and automatically operable from the control room by means of a SCADA system. The SCADA system will operate the control loops and will be utilised for overall process plant control. The plant will be controlled by the PLCs that will be housed in the various motor control centres (MCCs). Each MCC building will be equipped with a smoke and/or fire detection system that will be connected to an alarm system.

Each drive will have the following inputs to the PLC:

- MCC healthy
- Field/local start
- Emergency stop
- Drive running

Each drive, with the exception of the spillage pumps (excluding the cyanide spillage pump), will have a Run Command output from the PLC.

The distinct plant areas will be represented in graphic form on individual SCADA screens. Each screen will display all the drives and instruments in that area, together with the status of the drives and the current value of the instruments. Alarms will be generated and displayed in a dedicated portion of the screen for the operator to action.

Drives can be individually started from the SCADA system and all interlocks between drives, for automatic sequential start-up or shutdown, will be carried out by the PLC. When required, the CRO can place each drive into field control mode.

The drive interlocks can be disabled and run in "maintenance mode" from the field stop/start station. Once the drive is placed back into SCADA mode, the interlocks will automatically be enabled. The drives will then have to be started in the correct sequence. The operators will be required to walk through the plant before start-up to make sure that it is safe to start any drive.
All PID (proportional, integral and derivative) loops will be monitored and controlled from the SCADA system. All analogue values will be logged into a historical file for a period.

6.4.2.2 Stopping and Starting of Equipment

All equipment motors will be fitted with local start/stop stations that will be situated in suitable positions (within visual range from the motors). The stop button acts as an emergency stop regardless of the control mode adopted. Activation of the local stop will cause a warning light to illuminate at the MCC panel. A facility for lockout of each drive for maintenance purposes will be installed within the MCC cubicles at the panel.

The jaw crusher, cone crusher, SAG mill, ball mill and conveyor motor starts will be fitted with a time delay (e.g. 30 s) on start-up and an audible warning siren.

Spillage pumps will be started manually on high sump level and will be fitted with low-level switches to stop the pumps automatically on low sump levels. Sumps that contain cyanide spillage will start automatically on high level and stop automatically on low level. They will also be fitted with a flashing light, an indication on the SCADA screen in the control room, and an audible alarm to indicate high levels.

6.4.2.3 Equipment Protection

All conveyors will be fitted with pull-wire switches along their entire accessible length and emergency stop speed sensors for low speed detection. Belt drift and tear switches and rip detectors will be installed on all long conveyors.

Dead boxes will be used to protect sliding or impact areas from excessive wear. Wear lining is used in cases where clay materials are present or dead boxes are not practical.

Feed bins will be protected from the direct impact of falling material by maintaining the level of feed material in the bin high enough to absorb the impact.

On all agitated slurry tanks, the agitators will be fitted with an alarm indication on the SCADA system to warn of accidental stoppage or motor trips. The agitator and/or pump will be interlocked with the tank low level to prevent agitator and/or pump damage.

The mills will be fitted with audible sirens to give a warning during stoppages.

Flow and pressure switches fitted on gland water service lines feeding slurry pumps will warn the CRO in the event of low gland water flow and pressure, respectively. Pressure gauges will be installed on gland service lines located at these pumps to give a visual indication of gland water pressure. Pressure-regulating valves fitted on the pipes feeding gland water to these pumps will regulate the gland water pressure.

Positive displacement pumps will be equipped with pressure relief valves and low-flow switches to ensure that the pumps will not run dry.

6.4.2.4 Running and Standby

Transport of processing material forms the heart of the process. Once a transport medium is not functional, the plant loses available running time.

All major pumps, except spillage pumps, will be fitted with running and standby pumps.

6.4.2.5 Measure and Control

Sampling of the leach feed and plant final tailings will be done using automatic slurry rotary vezin samplers located at the launder/pipe discharge into the tank.

The pH measurement will enable the appropriate lime addition to ensure proper pH control in the leach and cyanide detoxification circuits.

Some samples will be taken manually and will be used for process control and accounting purposes. These will include leach slurry (collected from the first leach tank), leach tails slurry (collected from the detox tank), loaded, acid-washed, eluted and regenerated carbon, acid wash and elution solutions, as well as bullion prills.

6.4.2.6 Hoisting and Lifting

Electrically powered hoists will be equipped with a handheld control operating keypad. Overhead cranes will be operator driven. A continuous audible siren will sound when the hoists and cranes are travelling.

Crawl beams will be fitted to assist with maintenance wherever the tower crane or mobile cranes cannot reach.

6.4.2.7 Health and Safety

Safety showers will be equipped with a flow switch, which when activated will initiate an audible siren and a flashing light to alert the plant operating team that an incident has occurred. This will mobilise the necessary emergency response team to attend to the injured party.

Gas detection systems, fitted with audible sirens, will be in place at relevant process areas to warn personnel of any hazardous gases.

The large operating valves that will be impractical to operate manually will be remotely operable by pneumatic actuation. Minor process valves and hosing and flushing points, gland service, pump and tank drain valves will be operated manually.

A dust suppression system will be installed at the primary crushing tip area using water sprays that will be activated by the crusher operator once a dump truck offloads ROM into the tip bin. Further dust suppression will be carried out in the jaw crusher, crusher discharge and the stockpile area by linking the dust suppression system to the minimum tonnage set point from the mill feed conveyor. If the tonnage drops below the minimum, the dust suppression system will automatically stop until the minimum tonnage is exceeded.

Cyanide storage, mixing or dosing areas will be fenced off to prevent unauthorised access, thereby reducing the risk of injury. Flanges that will be used on cyanide lines will be fitted with flange covers. Cyanide drain valves will each be fitted with a second isolation valve and a blank flange with a weeping hole to indicate leakage.

The plant will be fitted with appropriate signage, in the appropriate languages, to warn personnel of hazards or safety risks present in the relevant area.

6.4.2.8 Security

A closed circuit TV system will be installed to cover the gold room sections. These areas will be under constant, multiple video camera surveillance with recording facilities. Monitors will be installed in the plant offices, security guardhouse, and General/Plant Manager's office.

Access to plant areas will be by means of turnstiles that are opened by swipe card reading devices. Each employee's swipe card will be programmed with his/her individual security clearance status.

6.4.3 Crushing

The objective of process control and instrumentation in the crushing plant is to maintain operating conditions that result in an optimum throughput-product size relationship; obtaining maximum throughput at a constant product size.

Process control and instrumentation have been included in the crusher section for the following reasons:

- They allow the plant to operate at a chosen target level.
- They minimise the effect of disturbances.
- They reduce the effect of ore variability.
- They provide for safe and efficient start-up, operation and shutdown of the process.

The ROM or tipping bin will be equipped with an ultrasonic level transmitter, which will ensure that adequate operating levels in the bin are maintained in order to reduce excessive impact on the equipment during tipping of ore into the bin. A traffic light will flash green for trucks to tip into the feed bin on low level, amber when trucks may approach, and red when the bin is full.

The double idler crusher belt weightometer installed on the primary crusher discharge conveyor will control the feed rate to this crusher by varying the speed of the apron feeder. The mass meter will be used for metallurgical accounting purposes and will have local and SCADA displays of instantaneous and totalised tonnage. The belt magnet will be installed directly after the crusher discharge to remove any tramp metal.

A siren located in the crushing area will activate on start-up of the crushing area. Each conveyor will be equipped with a local siren that will activate typically 10 s before the conveyor starts. All conveyors will be equipped with low speed sensors.

Belt drift switches will be installed on the mill feed conveyor. An alarm will activate for a period (typically 10 s) and will trip the conveyor if the alarm condition still exists after this period.

Belt tear switches will be installed on long conveyors.

6.4.4 Grinding

The milling process will be very energy intensive, and thus is usually the most expensive operation. Effective and practical controls, and proper instrumentation will therefore be critical to allow the milling circuit to run smoothly and as close to optimum as possible.

The milling circuit control objectives are as follows:

- Achieve a maximum throughput of 150 t/h whilst keeping the mill discharge density at 75 % solids for the SAG mill and 70 % solids for the ball mill.
- Achieve an optimum grind (80 % passing size 75 µm) whilst maintaining a plant design throughput of 1.2 Mtpa.
- Achieve a consistently optimum cyclone overflow slurry solids concentration of 45 % solids by weight whilst satisfying all other requirements.

A weightometer will be installed on the stockpile reclaim conveyor that feeds the SAG mill. It will allow for the control of SAG mill feed tonnage, and process water addition into the SAG mill feed and discharge sump for dilution and metallurgical accounting purposes.

Magnetic flowmeters and air-actuated valves will be installed on the process water line in the milling section to ratio control the water addition to the SAG mill discharge sump to maintain set densities in the mill discharge and feed to the cyclone cluster, respectively.

The motor amperage and power draw of each mill will be indicated on a display in the control room. The ball mill power draw will be adjusted by charging more balls or allowing balls to grind out.

The SAG mill feed dilution process water flow will be measured by a magnetic flowmeter that will be installed on the process water pipeline. It will be adjusted by varying the position of the air-actuated valve to match the set point calculated from a ratio of the feed tonnage measured by the mill feed conveyor weightometer and the desired mill discharge solids content.

The mill discharge sump will be equipped with an ultrasonic level transmitter to control the sump level by varying the speed of the mill pumps. The pressure of the feed slurry to the cyclone cluster will be controlled automatically by the SCADA system, by opening and closing the cyclone feed-actuated pressure control valves, to achieve the set pressure (to be specified by the vendor) in the feed distributor which is measured by a pressure transmitter.

The cyclone underflow splitter box will be equipped with three plug valves to enable feeding of a portion of the underflow to the SAG mill (if required) and the rest of the underflow to the ball mill. These valves will only be actuated and operated from the field using a manual solenoid lever.

The SAG and ball mill's lubrication control philosophy will be part of the vendor supply. The control philosophy will encompass instrumentation that will monitor mill drive motors, gear sprays, and trunnion bearings. The control philosophy will provide permissive signals as well as alarms and trip signals for the mills.

6.4.5 Trash Handling

Manual isolation valves will be installed on the spray water lines to the trash vibrating screen. These valves will be fully open during normal operation. The operator will need to conduct a field check to ensure that the valves are open prior to start-up.

6.4.6 Carbon in Leach

6.4.6.1 Sampling

A two-in-one slurry sampler will be installed on the CIL feed. The sampler set-up will incorporate a primary cross-cut slurry sampler and a secondary vezin sampler, which will deliver timed pulp increments to a sealed sample bucket representing a shift composite. The bucket will be lined with a plastic bag to contain the sample. A small amount of ferrous sulphate will be added to the tailings sample container at the start of each shift to prevent leaching of the sample in the container.

The CIL circuit will mostly be controlled manually by the operators. A cabin equipped with basic analytical and sampling equipment will be provided and used as a shift laboratory. It will be located on top of the CIL tanks. Slurry samples will be taken manually and filtered where necessary. They will be analysed and the results thereof will be used for process control and accounting purposes.

Regular sampling and analysis of the following will ensure proper control of the CIL circuit:

- Lime concentration
- Cyanide concentration
- Carbon concentration

6.4.6.2 Reagents Control

Lime addition to the mill feed will be controlled in the form of a cascade loop. Under normal operating conditions, lime powder will be fed onto the mill feed conveyor by the lime screw feeder at a ratio-controlled feed rate relative to the tonnage fed to the SAG mill. If required, lime will be automatically added to the leach feed splitter box to achieve a set pH of 9.5 to 10.5. A pH probe located in CIL tank 1 will be used to monitor the pH levels reporting to the CIL. In the event of the pH levels falling below a certain set point; the modulating lime feed valve will be controlled using output from the pH probe until the pH rises to the required values.
The dosing of cyanide to CIL tank 1 will be automatically controlled. A flow transmitter and a flowmeter will be provided on the cyanide line going to CIL tank 1. The cyanide flow set point will

be proportional to the fresh feed mass flow rate into the SAG mill, as measured by a weightometer on the SAG mill feed conveyor. The mill feed rate controller will send a signal to the cyanide flow controller to calculate the volumetric flow rate of the cyanide required in CIL tank 1. The cyanide flow control valve will open or close accordingly until the set point is attained. Cyanide can also be added to CIL tanks 2 and 3 via manual valves.

The cyanide addition rate will be displayed on the SCADA screen. Sampling and analysis for cyanide in solution will be conducted regularly (for example every hour) to determine the cyanide levels in the CIL tanks.

Low pressure air will be injected into the CIL tanks by means of spargers. Pressure gauges will be installed on each airline going into the CIL tanks to enable pressure measurements.

6.4.6.3 Intertank Flow

Intertank flow will be controlled manually by opening and closing the respective plug valves feeding each tank. Each tank will be provided with a bypass to be used in the event that the subsequent tank is offline. Carbon transfer will be started manually and the installed timers will stop the pump automatically.

6.4.7 Cyanide Detoxification

Cyanide gas emissions from the detoxification area will be monitored with a cyanide gas detector. If cyanide gas emissions reach unacceptably high levels, a siren will sound and the alarm on the SCADA system will indicate to the operator where the problem is.

Slurry samples will be taken manually from the detoxification tank and filtered on a regular basis. Titrations will be carried out on the filtrate for analysis of the concentration of WAD cyanide.

Lime will be automatically added to adjust the pH during the cyanide detoxification process. A pH probe located in the detoxification tank will be used to monitor the pH levels. When the measured value is lower than a set point, the lime feed valve will open to add more lime until the pH rises to the required set point, and vice versa.

The detoxification feed dilution process water flow will be manually controlled by adjusting the position of the process water dilution valve to the detoxification tank to achieve the desired density set point from the densitometer on the final tails discharge line.

The final tailings tank will be equipped with an ultrasonic level transmitter to control the tank level by varying the speed of the tailings dam feed pump.

A slurry sampler will be installed on the detoxification tank overflow discharge stream. The sampler set-up will incorporate a two-in-one rotary vezin sampler that will deliver timed pulp increments into a sample bucket that will contain a shift composite sample. The bucket will be lined with a plastic bag to prevent any sample spillage. A small amount of ferrous sulphate will be added to the tailings sample container at the start of each shift to prevent leaching of the sample in the container.

6.4.8 Acid Wash

The acid wash tank will be equipped with an ultrasonic level transmitter to measure the level of the fluid in the tank. The level transmitter will also be used to stop the acid wash pump on a low tank level and will stop the dilute hydrochloric acid transfer pump on a high level in the acid wash tank.

The line for caustic addition to the acid wash tank will be equipped with a flow transmitter and the totalised amount of caustic will be indicated on the SCADA system on completion of the neutralisation step.

The acid wash operation will be a fully manual operation with all the steps being carried out by an operator. The process will involve the following steps:

- Back-washing of the carbon batch with raw water to remove any light trash such as slimes, plastic and organic trash captured in the bed
- Acid washing of the carbon batch by circulating 3 % HCl solution through the carbon bed
- Rinsing of the carbon batch with raw water to remove all the chlorides on the carbon surface

6.4.9 Elution

The eluant tank will be equipped with an ultrasonic level transmitter to measure the level of fluid in the tank. The level transmitter will also be used to stop the elution pumps on a low tank level.

The magnetic flow transmitters, one on the caustic line and another on the cyanide line, will measure and totalise the required amounts of caustic and cyanide to be added to the eluant tank during eluant make-up.

The elution column will be equipped with the following instrumentation for safety and ease of operation:

- Temperature gauge and transmitter for measurement of column exit temperature
- Pressure gauge and transmitter, which will trip the elution pumps in the event of the pressure in the column exceeding the maximum set value
- Pressure relief valve
- Bursting disc as an added precaution for overpressure in the column
- Vacuum relief valve

Temperature and pressure gauges on the inlets and outlets of the heat exchangers will measure and indicate the temperature and pressure changes across the heat exchangers.

The elution process will be a semi-automatic process with some sequences initiated by the operator and carried out by the PLC, while others will be carried out by the operator. The elution process is carried out in the following steps:

- Circulation of solution from the eluant tank through the heat exchangers (to preheat it to 80 °C) and back to the tank when a fresh eluant batch has been made.
- Heating of the column and its contents by opening the actuated valve at the column entrance and closing the valve on the line going back to the eluant tank. During this stage, the eluant will be circulated through the recovery heat exchanger, the primary heat exchanger, the column, and back into the eluant tank. This stage continues until the temperature exiting the column reaches 125 °C.
- When the column exit temperature decreases to 120 °C, the eluate from the elution column will be directed to the electrowinning facility by opening the actuated valve to electrowinning and closing the eluate circulating valve.

The elution heating system will be a vendor package complete with its own control philosophy. All signals will be relayed to the PLC.

6.4.10 Carbon Regeneration

The regeneration kiln control philosophy will be part of the vendor package. The kiln will have a dedicated control panel and will be locally operated in the field. Certain signals will be relayed to the PLC for information display on the SCADA system.

Other equipment and services (such as the quench screen, quench water and spray water) will be operated and controlled manually.

6.4.11 Electrowinning

The current and voltage of the electrowinning cells will be indicated at the rectifiers, located in the rectifier room outside the gold room and at the SCADA station in the control room. Each rectifier will be equipped with a potentiometer, which will be manually controlled to maintain the cell voltage and current.

The electrowinning circuit will have a gas detector unit to detect the presence of HCN, NH_3 and H_2 in the area. If a high concentration of any of these gases is detected, an audible warning siren will sound and an alarm on the SCADA system will be activated.

6.4.12 Gold Room

The calcining and smelting furnaces will be part of a vendor package which will include temperature control systems.

Digital electronic scales will be provided to record the masses of the gold bullion bars, sample prills and fluxes.

The gold room will be equipped with an alarm system with passive motion detection, door proximity switches, and a system arming/disarming keypad transmitting to the Mine Security Offices. The alarm system will be armed whenever the gold room is vacated. The bullion strong-room will be equipped with a timer and a digital keypad-type combination lock system as well as full dual locks for two separate designated key holders.

6.4.13 Services

6.4.13.1 Compressed Air

The compressors will have an automatic controller, which will continuously measure the system pressure and will start and stop the unit as and when required. This will be part of a vendor package. The controller will alternate between the two compressors (leaving one as standby) and will be able to start both compressors when required.

The air receivers will be fitted with automatic condensate drain valves that will drain any accumulated moisture from the vessel, as well as a pressure gauge and pressure relief valve to prevent overpressure in the receivers.

Dedicated pressure switches will be installed on the plant and instrument air headers to indicate the operating pressure on the SCADA system.

The oxygen plant will be a vendor package complete with its own control philosophy. All signals will be relayed to the PLC.

6.4.13.2 Water

6.4.13.2.1 Process Water

The process water tank will be equipped with an ultrasonic level transmitter that will be used, together with the actuated valves on the tailings return water and raw water top-up lines, to maintain the level in the tank. The two actuated valves will close when the tank level is high. If a low level is measured for an extended period of time, the process water pumps will be stopped, thus stopping the ore feed to the milling circuit.

6.4.13.2.2 Raw Water

During normal operation (after start-up), raw water will be pumped from the raw water dam to the raw water tank in the plant. The raw water tank will be equipped with an ultrasonic level transmitter that will be used to maintain the level in the tank. Upon a high-high level, the actuated valve will close. If a low level alarm is activated, an alarm signal will be sent to the SCADA system for the operator to take action in the event of no top-up water being fed to the raw water. When a low-low level alarm in the tank is activated, the raw water, gland water and carbon transfer pumps will stop.

6.4.13.2.3 Potable Water

The control philosophy of the potable water treatment plant will be part of the vendor package. The potable water storage tank will be equipped with an ultrasonic level transmitter that will trip the potable water pumps on low-low level.

A hydrosphere will be used to maintain the pressure in the potable water headers. Pressure switches will be interlocked with the upstream potable water pumps that will keep the hydrosphere full.

The safety shower water tank will have a float valve that will close when the tank is full.

6.4.13.2.4 Gland Water

Gland water will provide gland sealing water for all the slurry pumps with the required flow rates and pressures. The pumps will be protected by a level transmitter on the gland water tank. The filters on the pump discharge line will be installed with pressure switches. The gland water pumps will be interlocked with the pressure switches and when a high pressure alarm is activated across the water filter, the pump will stop.

6.4.13.2.5 Fire Water

A pressure transmitter on the fire water pump discharge line will be used to control the start-up of the electrical fire water pumps. If the pressure in the line drops below a specified set point, the electrical pump will start. In the event that there is an electrical failure and the pressure in the line has dropped below the set point, the diesel pump will start.

6.4.13.3 Reagents

6.4.13.3.1 Lime

The lime make-up will be a manual operation. The lime make-up tank will be equipped with an ultrasonic level transmitter for monitoring the level in the tank. The make-up water will be added manually by opening and closing the process water actuated isolation valve. The ultrasonic level transmitter installed on the make-up tank will be used to determine when sufficient water has been added to the tank. The lime transfer pump will be interlocked with the low level in the make-up tank. The transfer pump will also be interlocked with the high level in the dosing tank.

The lime dosing tank will be equipped with an ultrasonic level transmitter for monitoring the level in the tank. Lime dosing to the CIL and the detoxification circuits will be via a ring main using pH probes, flow control valves, and magnetic flowmeters.

6.4.13.3.2 Caustic Soda (Sodium Hydroxide)

The caustic make-up will be a manual operation. The caustic tank will be equipped with an ultrasonic level transmitter that will be used to monitor the water addition during make-up by opening and closing the raw water actuated isolation valve. The dosing of caustic to the cyanide make-up and acid wash tanks will be monitored using flow transmitters, one on each of the two dosing lines. The amount of caustic added in each case will be totalised and indicated on the SCADA system.

6.4.13.3.3 Cyanide

The cyanide make-up will be a manual operation. The cyanide make-up and dosing tank will be equipped with an ultrasonic level transmitter that will be used to monitor the addition of raw water during make-up by opening and closing the actuated valve.

The dosing of cyanide to the CIL will be via the ring main and flow control will be achieved by using a flow control valve and magnetic flowmeter. Cyanide dosing to elution for eluant make-up will be totalised and indicated on the SCADA system.

A hydrogen cyanide gas detector will be installed at the cyanide make-up and dosing points (throughout the plant) which will set off an audible alarm and rotating light if high levels are detected.

6.4.13.3.4 Copper Sulphate

The copper sulphate make-up will be a manual operation. The make-up water will be added by opening and closing the raw water actuated isolation valve. The ultrasonic level transmitter on the mixing tank will be used to determine when sufficient water has been added to the tank. The level transmitter will be used to stop the copper sulphate dosing pumps on a low level in the tank.

Copper sulphate dosing will be carried out manually using the results from the titrations that are carried out on the regular samples taken to check the concentration of WAD cyanide in the detoxification tank.

6.4.13.3.5 Sodium Metabisulphite

The sodium metabisulphite make-up will be a manual operation. The make-up water will be added through opening and closing of the raw water actuated isolation valve. The ultrasonic level transmitter on the mixing tank will be used to determine when sufficient water has been added to the tank. The level transmitter will be used to stop the sodium metabisulphite dosing pumps on a low level in the tank.

Sodium metabisulphite dosing will be carried out manually using the results from the titrations that are carried out on the regular samples taken to check the concentration of WAD cyanide in the detoxification tank.

6.5 EQUIPMENT LIST

Refer to Annexure 6-5.

6.6 PROCESS FLOW DIAGRAMS (PFDS)

Refer to Annexure 6-6 for a complete set of the process plant PFDs. Figure 6-6 shows the overall Tulu Kapi flowsheet.

6.7 PIPING AND INSTRUMENTATION DIAGRAMS (P&IDS)

Refer to Annexure 6-7 for a set of the process plant P&IDs.

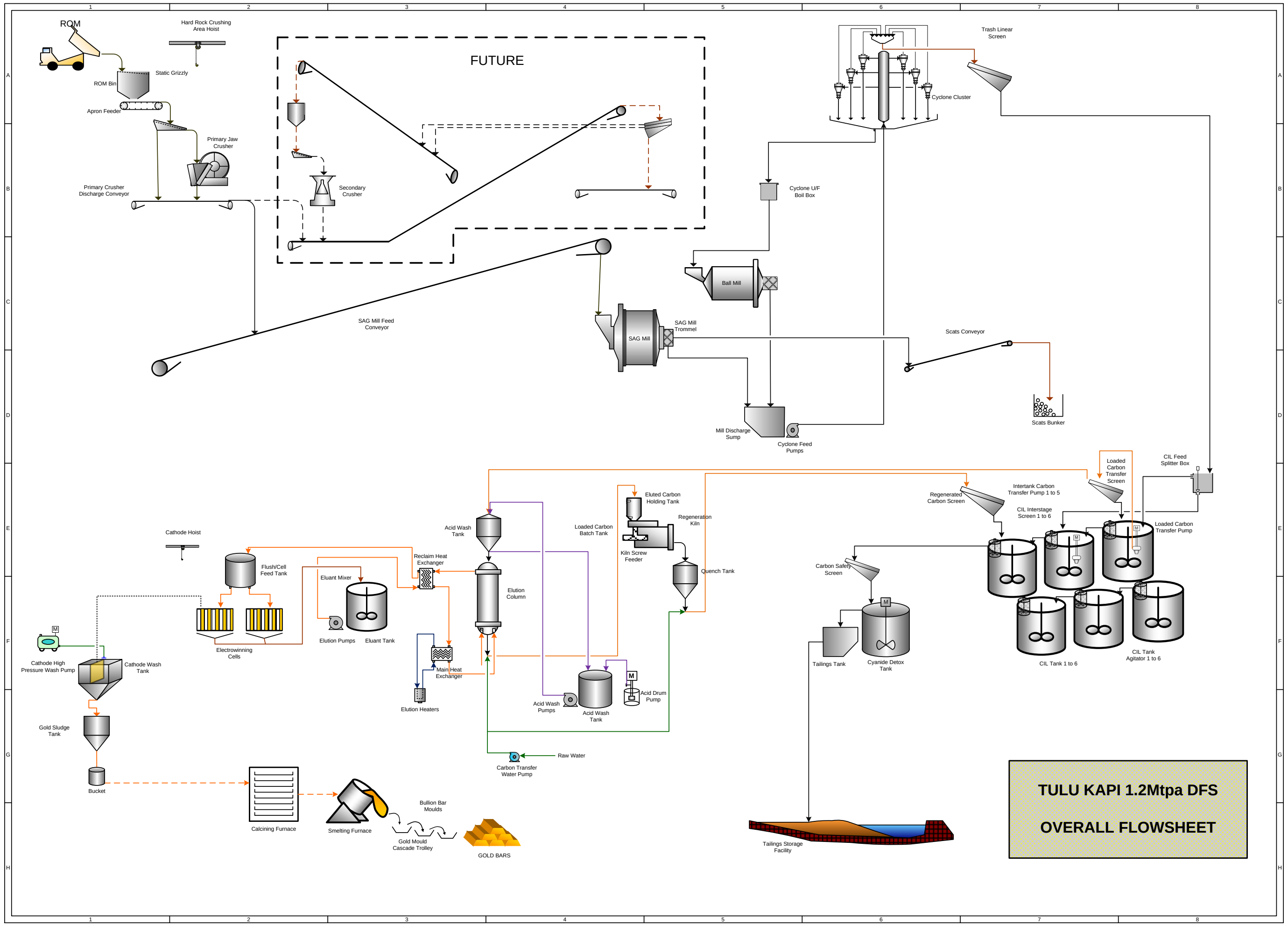

Figure 6-6: Overall Tulu Kapi Flowsheet

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7.1 TAILINGS STORAGE FACILITY (TSF)

Mine tailings consist of the residual processed ore that has passed through the processing plant. The tailings are expected to range in particle size from 75 % to 80 % passing 75 microns (µm), and are transported to the tailings storage facility (TSF) as a slurry. The tailings slurry is deposited into the TSF in a controlled manner to systematically fill the TSF from the starter dam perimeter inward towards the centre. The tailings solids will settle out of the slurry into the TSF and the slurry water component is subsequently pumped back to the process plant for reuse in the plant and for tailings transport to the TSF.

The TSF, as currently designed, has an ultimate storage capacity for tailings generated at a rate of 1.2 Mtpa for the anticipated 13 year life of mine (see Section 7.1.2). The TSF containment wall will consist of compacted soil and mine waste rock that will be constructed in four phases as summarised in Table 7-1.

Table 7-1: Summary of 13-year TSF Storage Capacity

Parameter	Unit	Phase 1	Phase 2	Phase 3	Phase 4
Life of Mine	years	1	2	6	13
Tailings Production Rate (dry)	kt per month	100	100	100	100
Tailings Production Rate (dry)	ktpa	1 200	1 200	1 200	1 200
Total	Mt	1.2	2.4	7.2	15.4
Volume	10^6 m^3	0.90	1.80	5.41	11.6

The TSF and raw water diversion dam (RWDD) locations are shown in Figure 7-1.

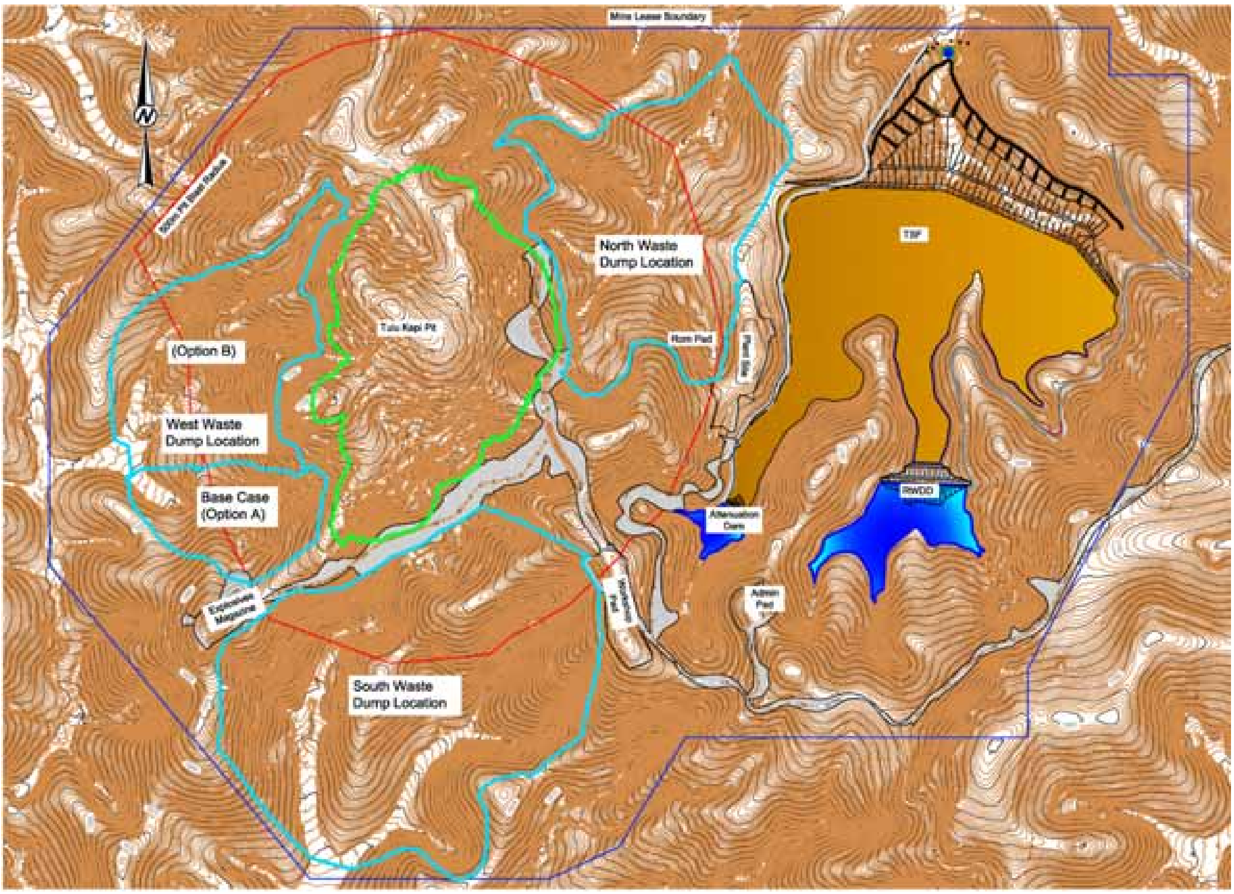

Figure 7-1: Location of TSF and RWDD

7.1.1 Selection of the Preferred TSF Site

The selection of a preferred site for the construction of the proposed TSF has included consideration of a number of options which have been evaluated against a set of site selection criteria.

7.1.1.1 Site Selection Criteria

The selection of a preferred site for the establishment of a TSF includes consideration of a range of technical and environmental issues. The information used to support the evaluation of environmental issues in the site selection process has been sourced from investigations of the project area by specialist scientists as part of the environmental impact assessment (EIA) process. The environmental assessment process requires that options be considered for the location of key project infrastructure. Specialist studies carried out during the EIA process have included evaluation of the candidate sites.

The selection of candidate sites for the development of the TSF has been based on the following:

- Proximity to the centre of the proposed mining and processing operations
- Topography of the areas available for development
- Capacity of the potential sites to store the anticipated volume of tailings
- Avoidance of areas of existing or potential mining activity
- Avoidance of significant surface water drainage systems
- Avoidance of existing infrastructure and residents

7.1.1.2 Description and Preliminary Assessment of Candidate Sites

The candidate sites for the establishment of the proposed TSF are shown in Figure 7-2. Conceptual site layouts and stage capacity curves have been developed for each of the options. The site layouts and associated stage capacity calculations were based on the construction of starter embankments and the upstream self-raising of the tailings above the levels of those embankments. The results of the stage capacity calculations have been summarised in Table 7-2 and show that all of the sites have the required tailings storage capacity to satisfy the design criteria. The options are described briefly below.

7.1.1.3 TSF Option 1

TSF Option 1 is near the location of SRK's conceptual TSF layout. This option may encroach on the plant site, but it is expected that this impact would easily be mitigated with the use of engineered berms. The proposed site layout would impact on three drainage lines. Option 1 has the lowest volume of material required for construction of the TSF starter embankment.

7.1.1.4 TSF Option 2

TSF Option 2 covers the proposed plant site as well as most of the proposed primary crusher site. This option also potentially encroaches on the proposed portal to the future underground workings and has therefore been excluded from further consideration.

7.1.1.5 TSF Option 3

TSF Option 3 encroaches on the plant site as well as some of the primary crusher site and has therefore also been excluded from further consideration.

7.1.1.6 TSF Option 4

TSF Option 4 is located away from all of the proposed mine infrastructure. Most of the proposed site is, however, located outside of the currently approved mine lease area. For this reason, as well as the fact that it has the largest impact on the surface water environment, this site has also been excluded from further consideration.

7.1.1.7 TSF Option 5

TSF Option 5 does not interfere with the process plant or primary crusher site, and the potential impact to the mine portal area can be mitigated with an engineered berm. Option 5 has the smallest footprint area and is located in the smallest catchment of all the sites. It is also down gradient of the proposed waste dump and would capture run-off from the waste dump. The proposed site has the second smallest starter embankment.

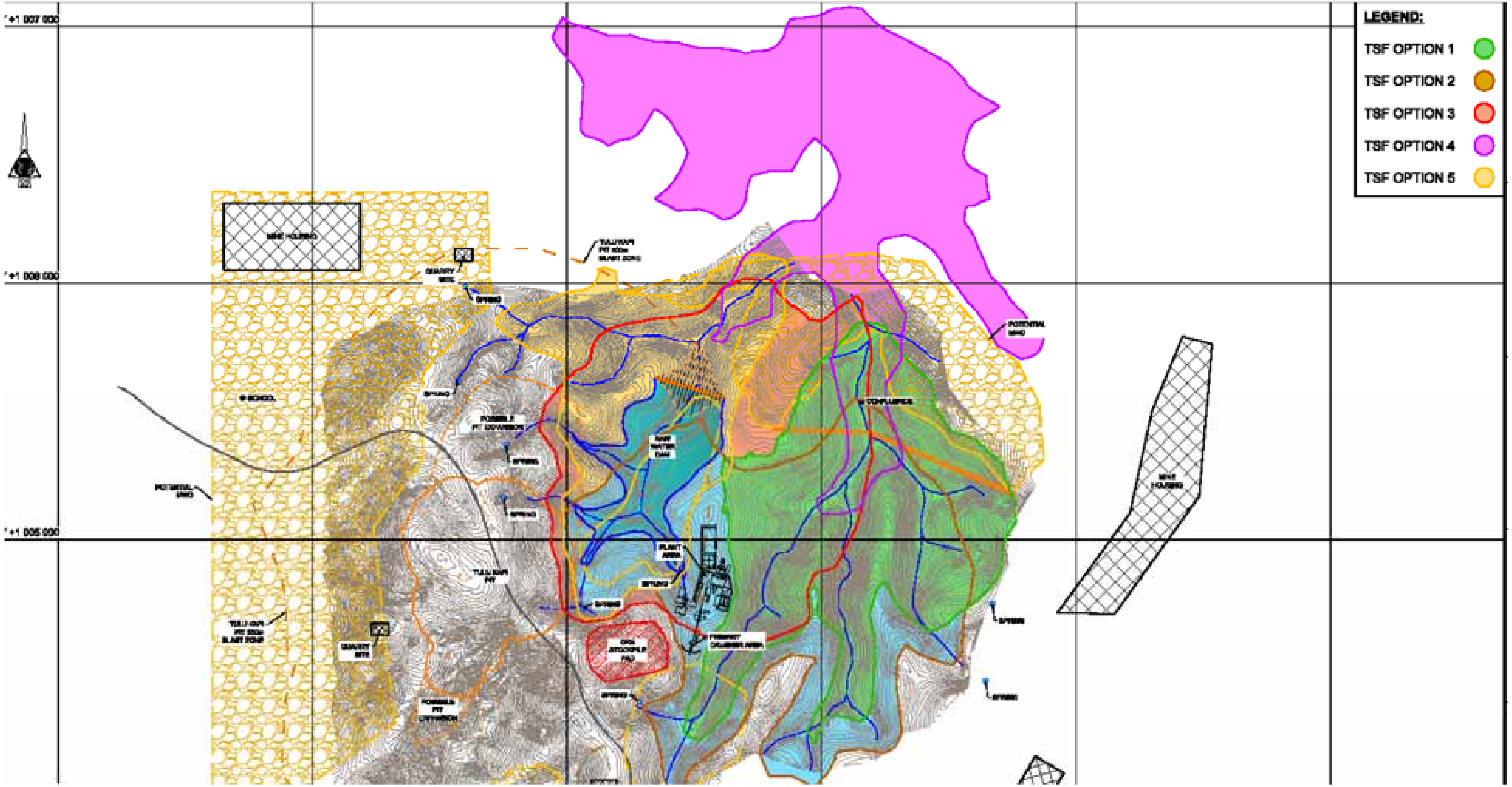

Figure 7-2: Candidate Sites for the Establishment of the TSF

Table 7-2: Summary Stage Capacity Calculations – Candidate TSF Sites

Parameter	Unit	TSF Option 1	TSF Option 2	TSF Option 3	TSF Option 4	TSF Option 5
Datum Level	mamsl	1 605	1 625	1 625	1 575	1 615
Starter Wall Outer Slope	1V:xH	5	5	5	5	5
Starter Wall Elevation	mamsl	1 642	1 662	1 667	1 615	1 655
Starter Wall Crest Width	m	8	8	8	8	8
Starter Wall Length	m	550	1 626	2 183	862	484
Starter Wall Inside Slope	1V:xH	2	2	2	2	2
Starter Wall Footprint	m^2	98 354	329 675	548 390	150 886	103 694
Starter Wall Volume	10^6 m^3	1.215	5.961	5.961	2.258	1.455
Final Tailings Elevation	mamsl	1 658	1 685	1 700	1 620	1 685
Perimeter Length	m	5 713	6 246	2 945	9 639	3 637
TSF Footprint	ha	107	148	143	134	85
TSF Volume	10^6 m^3	22.9	28.3	33.5	21.1	20.6

7.1.1.8 Selection of Preferred Site

Based on the description of the sites, the associated assessment of their suitability, and the (2012) Definitive Feasibility Study (DFS) report production figures it was determined that only TSF Options 1 and 5 were suitable for development as tailings storage facilities.

With further evaluation of TSF Options 1 and 5 and discussions with the project team, it was decided that Option 1 was the preferred site for the development of the TSF. This decision was based on the following:

- The proximity of TSF Option 5 to the open pit and the possibility that mineralisation associated with that pit may extend to the TSF footprint area
- The location of TSF Option 1 down gradient and immediately adjacent to the plant) which would enable it to serve as a contaminated water containment system to the plant and surrounding areas
- The lower overall height of TSF Option 1

7.1.1.9 TSF Ultimate (13-year) Stage Capacity Calculations

The detailed ultimate stage capacity calculations carried out for TSF Option 1 are summarised in Table 7-3.

Table 7-3: Summary of the Ultimate (13-year) Stage Capacity for TSF Option 1

Parameter	Unit	Phase 1	Phase 2	Phase 3	Phase 4
Time	years	1	2	6	13
Storage Required	Mt	1.2	2.4	7.2	15.4
Tailings Elevation	mamsl	1 618	1 624	1 639	1 656
Crest Elevation	mamsl	1 620	1 626	1 641	1 652
Datum Level	mamsl	1 595	1 595	1 595	1 595
Height above Datum	m	25	31	46	61
Depositional Area	ha	11.61	17.18	36.32	40.6
Rate of Rise	m/a	7.75	5.24	2.48	2.22
Containment Wall Lift Volume (including backfill box cut and key)	m^3	403 270	381 385	1 338 351	N/A
Containment Wall Material Type		Silty Clay/Clay	Selected Waste Rock	Selected Waste Rock	N/A
Construction Period	months	18	6	48	72
Average Rate of Construction	10^3 m^3/month	33.6	31.7	55.8	55.7

The development plan for the facility as represented by the stage capacity relationships is described below and is aimed at ensuring that the facility satisfies the requirement to store the expected production of 15.4 Mt of tailings at rates of up to 1 200 ktpa. The stage capacity calculations are based on a site development strategy comprising the following:

- The construction of a Phase 1 containment wall to an elevation of 1 620 mamsl to provide 1 year's contained storage capacity. The Phase 1 containment wall will be completed before tailings deposition into the facility commences. The Phase 1 containment wall will comprise two phases as follows:

  - Phase 1A, which is the construction of the starter embankment to an elevation of 1 615 mamsl. Phase 1A will require 200 808 m^3 of low to medium plasticity clay and will be constructed during Year 0 of LOM.
  - Phase 1B, which is the first lift to the embankment and will be constructed to an elevation of 1 620 mamsl. Phase 1B will require 202 462 m^3 of silty clay or clayey silt and will be constructed during the first two quarters of Year 1 of LOM.

- The construction of a Phase 2 containment wall to an elevation of 1 626 mamsl to provide an additional year's contained storage capacity. The Phase 2 containment wall will require 381 385m^3 of selected waste rock and will be constructed during the last two quarters of Year 1 of LOM.

- The construction of a Phase 3 containment wall to an elevation of 1 641 mamsl to provide an additional four years' contained storage capacity. The Phase 3 containment wall will require 1 338 351 m^3 of selected waste rock and will comprise the following lifts:

  - First lift — to be constructed during Year 2 of LOM with 669 176 m^3 of material required
  - Second lift — to be constructed during Year 3 of LOM with 223 058 m^3 of material required
  - Third lift — to be constructed during Year 4 of LOM with 223 058 m^3 of material required
  - Fourth lift — to be constructed during Year 5 of LOM with 223 058 m^3 of material required

- Self-raising the facility (Phase 4) from 1 641 mamsl to 1 656 mamsl to provide the final seven years' tailings storage capacity. Due to Phase 4 being self-raised, the final tailings elevation (1 656 mamsl) will be higher than the final crest elevation (1 654 mamsl) of the containment wall.

The site development strategy is focussed on the use of selected mining waste to construct the containment walls until such time that the rate of rise of on the facility reaches a point at which self-raising becomes feasible (< 2.5 m/a). During the last seven years of the development of the facility, deposition cycles should be arranged so as to accelerate the construction of the day wall above the level of the tailings basin to create the freeboard required to facilitate fluctuations in post-closure water levels.

The end of construction of Phase 1, Phase 2, Phase 3 and Phase 4 can be seen in Figure 7-3, Figure 7-4, Figure 7-5 and Figure 7-6, respectively.

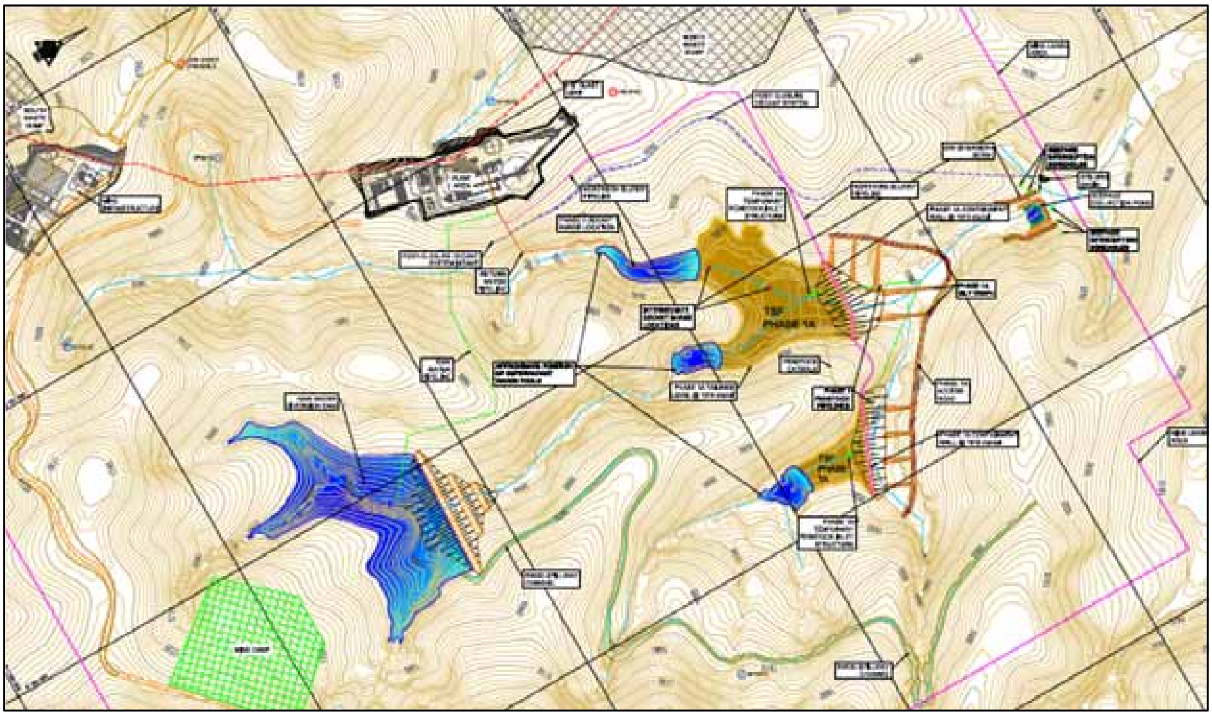

Figure 7-3: Phase 1 of Tulu Kapi TSF

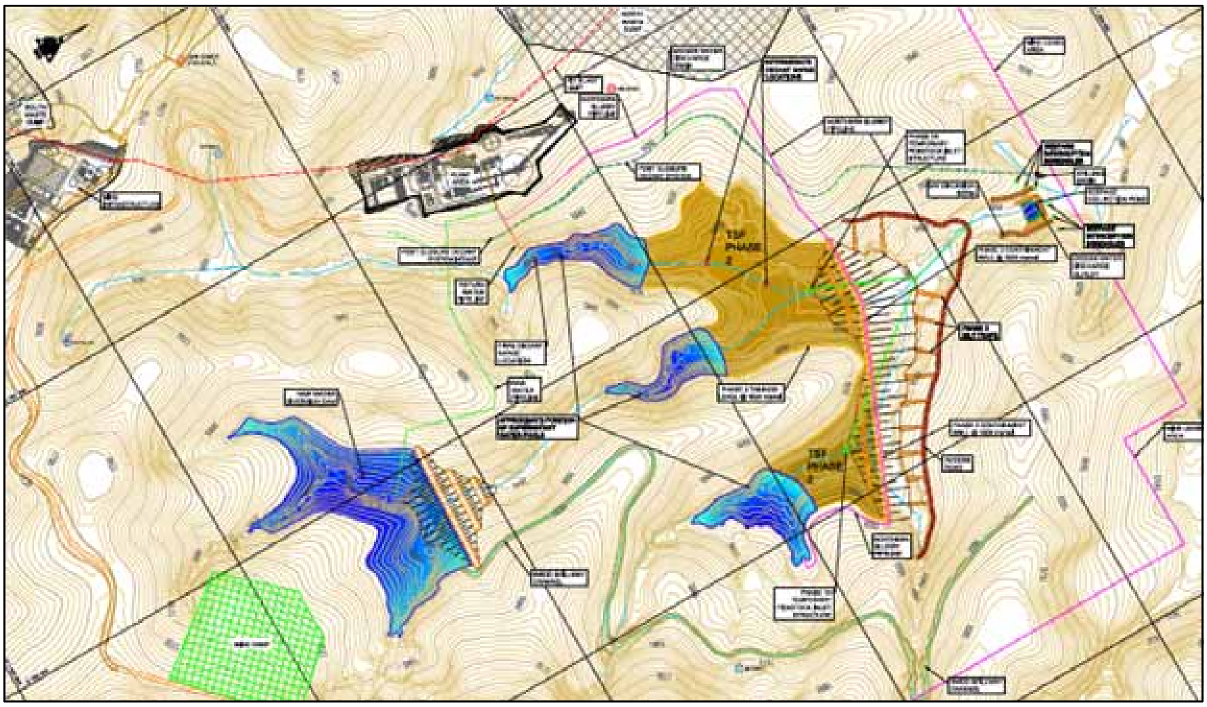

Figure 7-4: Phase 2 of Tulu Kapi TSF

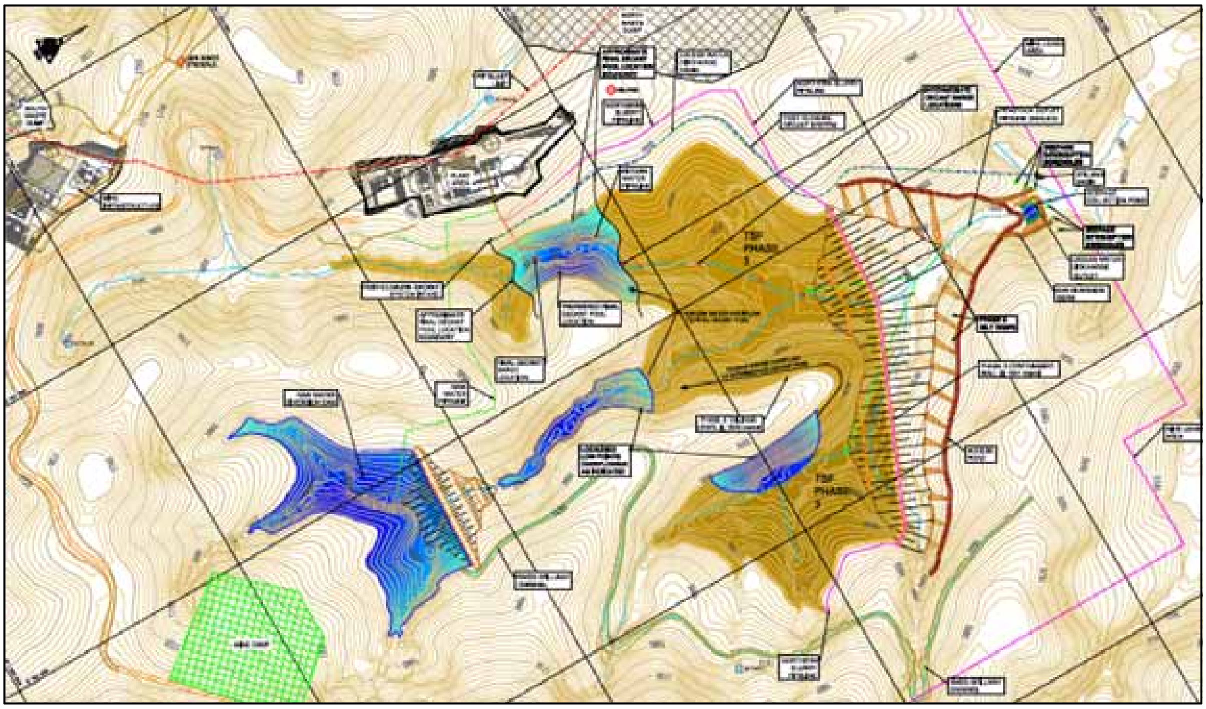

Figure 7-5: Phase 3 of Tulu Kapi TSF

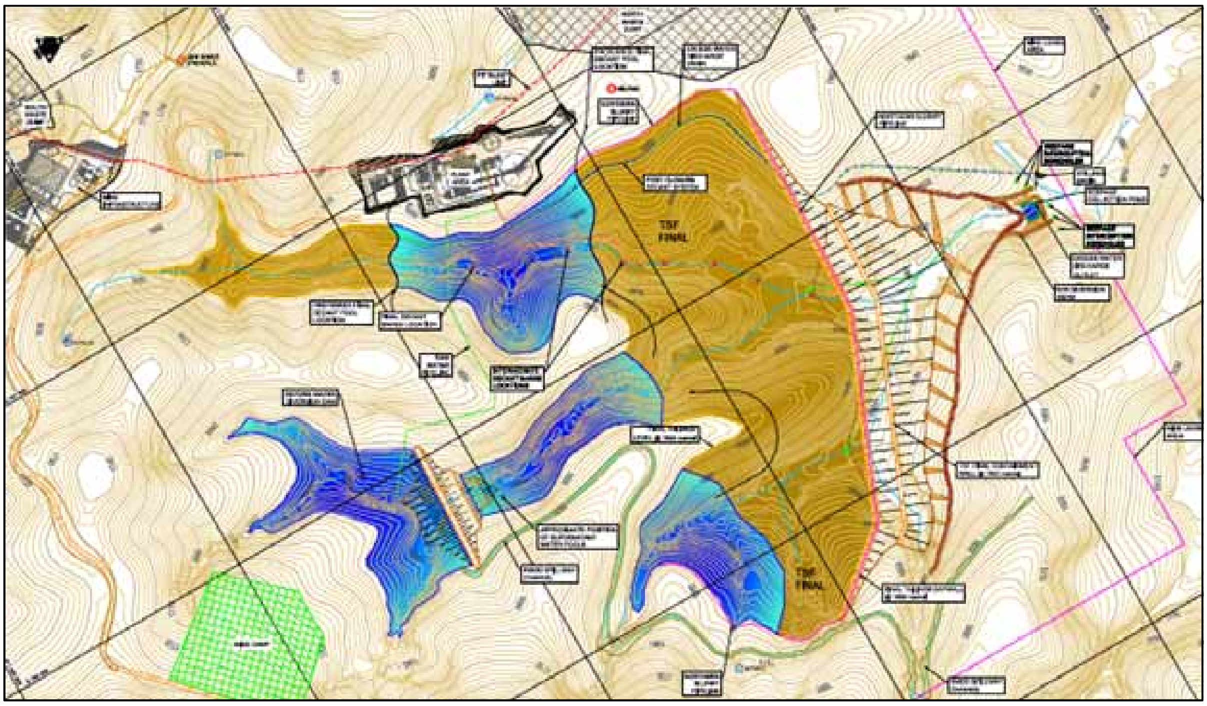

Figure 7-6: Phase 4 of Tulu Kapi TSF

7.1.2 TSF Ultimate Design Criteria and Battery Limits

The criteria for the design of the proposed TSF are based on a revised ROM feed of 1 200 ktpa (100 kt per month) to the plant for a period of approximately 13 years during which 15.4 Mt of ore will be processed. At the expected in-situ dry density of 1.33 t/m³ which requires a storage capacity of 11.6 million m³ at the end of Phase 4, as summarised in Table 7-4. The properties of the tailings and slurry may be summarised as follows:

- Tailings particle size distribution: 75 % to 80 % passing 75 micron (see Figure 7-7), which is normal for a gold tailings product
- Tailings particle specific gravity: 2.80 t/m³
- In-situ dry density: 1.33 t/m³ based on an estimated average void ratio of 1.1
- Slurry density: expected to be 1.35 t/m³ based on a 40:60 solids to water split

Table 7-4: Summary of Tailings Production Schedule

Parameter	Unit	Phase 1	Phase 2	Phase 3	Phase 4
Life of Mine	years	1	2	6	13
Tailings Production Rate (dry)	kt per month	100	100	100	100
Tailings Production Rate (dry)	ktpa	1 200	1 200	1 200	1 200
Total	Mt	1.2	2.4	7.2	15.4
Volume	10^6 m³	0.90	1.80	5.41	11.6

7.1.3 Battery Limits for Design

The battery limits for the design of the TSF have been agreed upon as follows:

- The point at which tailings are discharged from the spigot pipelines installed to the TSF ring feed system
- The top surface of the decant pond
- The outer toe of the TSF

The overland slurry delivery pipeline and pumping system, as well as the return water pumping system, is being designed and costed by a separate design team.

7.1.4 Characterisation of Tailings Product

The design of tailings storage facilities to accepted standards requires that the residues to be disposed of be characterised in terms of their physical and geochemical characteristics as part of the design process. Characterisation of the Tulu Kapi tailings product has been based on the results of grading analyses carried out during metallurgical testwork and geochemical characterisation carried out as part of the ESIA. The expected characteristics of the tailings product are described below.

7.1.5 Physical Properties of Tailings Product

The physical characteristics of the tailings products are described in terms of their particle specific gravity (PSG) and particle size distribution (PSD). These characteristics are significant in that they will influence the in-situ dry density of the placed tailings product as well as the behaviour of the material on deposition, and hence the method of deposition. The expected physical characteristics of the material are summarised as follows:

- The tailings are expected to comprise gold tailings with a PSG of 2.8
- At an average in-situ void ratio of 1.1 the tailings are expected to have an in-situ dry density of 1.33 t/m^3
- The tailings are expected to have between 75 % and 80 % by mass passing the 75 micron screen as shown in Figure 7-7

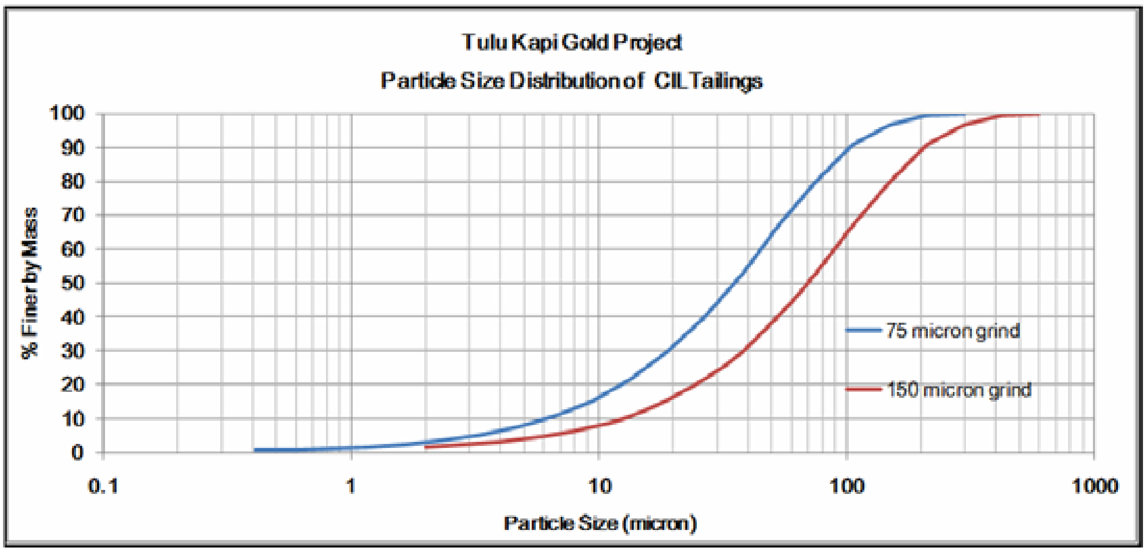

Figure 7-7: Tailings Particle Size Distribution

The tailings product is expected to behave as a conventional gold tailings product and form relatively flat beaches. The behaviour of the material may, however, be affected by the nature of the orebody, which includes large quantities of saprolites. These materials can be extremely fine, which may impact on the settling characteristics of the tailings.

7.1.5.1 Geotechnical Parameters of Tailings

The geotechnical characteristics of the tailings have been estimated based on a literature survey, the expected grading analysis of the tailings, and experience as summarised in Table 7-5.

Table 7-5: Expected Geotechnical Parameters for Tulu Kapi Tailings

Material	Bulk Unit Weight (kN/m^3)	Saturated Conductivity (ky) (m/s)	ky/kx	Effective Friction	Effective Cohesion (kPa)
Coarse Tailings - High Permeability	15 (± 1.0)	5.0×10^{-7}	1/2	32 (± 2.5)	0
Medium Tailings - Medium Permeability	15 (± 1.0)	1.0×10^{-7}	1/5	30 (± 2.5)	0
Fine Tailings - Low Permeability	14 (± 1.5)	1.5×10^{-8}	1/10	28 (± 2.5)	0

7.1.5.2 Tailings Geochemistry

Characterisation of the tailings geochemistry was carried out as part of the overall assessment of material properties on the mine site by a specialist hydrogeochemist (Harck, May 2012) based on a sample from the metallurgical testing process which was assumed to be representative of the tailings that would be produced in the processing of Tulu Kapi ore.

The testwork and analysis of the tailings sample concluded that sulphate accounted for most of the sulphur in the tailings sample and duplicate. The bulk ore samples included an oxide composite, which is expected to be rich in sulphate. However, it is not known whether the tailings were derived from this sample or a high sulphide bulk ore sample. The results of the testwork illustrated the following:

- The tailings generally have a net neutralising potential (NNP) greater than zero and neutralisation potential ratio (NPR) greater than two, which categorises them as non-potentially acid generating.
- The tailings samples are also categorised as potentially acid generating (PAG) from the net acid generation (NAG) test results. Since these samples have a very low sulphide content, the generation of acidity is attributed to the oxidation of iron and manganese dissolved from carbonate minerals in the tailings. This suggests that the Tulu Kapi tailings could be a source of long-term acidity.

The preliminary assessment of tailings geochemistry concluded that:

- The samples provided were in general characterised by significant concentrations of carbonate minerals. However, these are iron or manganese-bearing carbonates which do not contribute to Neutralising Potential (NP) under oxidising conditions. Under reducing conditions, such as within deep rock piles or saturated tailings, these carbonates will neutralise acidity and increase dissolved concentrations of iron and manganese. The iron and manganese enriched drainage will become acidic on discharge at surface where oxidising conditions prevail.

- The tailings appear to contain a latent acid potential from the dissolution of iron and manganese carbonates and the subsequent oxidation of dissolved iron and manganese. This suggests that tailings seepage may impact on environmental and water quality due to the following:

  - Dissolved iron and manganese, which are potentially toxic at high concentrations
  - Acidity, which can have toxic effects and also contributes to elevated concentrations of metals such as Pb, Cu, As, Ni and Zn

- Given the latent acid generation potential of the tailings sample, the installation of an engineered barrier to the footprint of the tailings storage facility should be considered as a precaution against surface and groundwater contamination. The extent of acid generation and leaching from the tailings should be confirmed through kinetic testing.
- Geochemical characterisation of the waste rock and tailings material at Tulu Kapi should be carried out. This should include the following:

  - Static geochemical testing of sufficient samples to confidently characterise the mass of mining-disturbed material. This may require several hundred samples (INAP 2009).
  - Kinetic testing to determine pyrite oxidation rates and the rate of depletion of neutralisation potential. Tailings, mafic syenite and diorite/basic dyke material should be included in the kinetic testing programme to confirm whether they are PAG or non-PAG. Albitised syenite and quartz vein material should be included to clarify effective Acid Potential (AP) and Neutralising Potential (NP).

Subsequent kinetic testing of a range of waste and ore samples (Golder, 2013) confirmed that albitised syenite and low grade ore are non-PAG in the short to medium term. They are, however, PAG in the long term. Tailings, unaltered syenite and diorite were found to be non-PAG. Based on the kinetic testing results, no changes are recommended to the mitigation measures that were proposed during the preliminary geochemistry assessment by Golder Associates (Golder) (2012) until representative samples of the various materials that will be disturbed by mining are assessed. Based on the work done to date no issues have been identified that cannot be satisfactorily mitigated.

Golder recommends that development of the water monitoring programme should include all the enriched metals (Ag, As, Ba, Cd, Mo, Na, Pb, Sb, W, and Zn) in addition to alkalinity, pH, SO_4^{2-} and leachable metals (Ca, Fe, K, Mn and Ni).

7.1.6 Beaching Simulations and Water Management on the TSF

Based on the expected build-up and use of water in the TSF as described in the previous section it is essential that the facility be operated in such a way as to ensure that its safety is not compromised.

It is intended that this will be achieved through a combination of the following:

- Constructing the TSF as a containment facility
- Managing the tailings deposition and beach formation

7.1.6.1 Tailings Deposition and Beaching Strategy

The deposition of tailings is expected to occur predominantly from the front wall of the TSF with the intention of ensuring that excess water is stored as far back from that wall as possible. The objective is for the decant pond and the majority of the excess water in the TSF to be located in the western finger of the TSF adjacent to the plant site. The storage of water in the central and eastern fingers of the TSF will be minimised by the deposition of tailings into those areas to create beaches directing run-off and excess slurry water towards the final decant pool position. It is essential that by the time the maximum tailings storage capacity of each phase is approached, the next phase of the containment wall will be above the level of the crest of the preceding TSF wall.

7.1.6.2 Containment Wall Construction and Water Management

It is expected that the construction of the TSF will commence with the construction of the Phase 1A starter embankments to an elevation of 1 615 mamsl, which will create a short-term storage capacity for storm water run-off up to the 1 613 mamsl level, which is 2 m below the crest. The construction of the embankments is expected to be timed to be complete before the onset of the rainy season prior to the commissioning of the plant to ensure that the storage capacity is available for the commencement of operations. Construction of the containment wall to the 1 620 mamsl level would then continue so as to be completed before the commencement of tailings deposition to ensure sufficient tailings and water storage capacity for the first year of operations.

Each of the starter embankments will be equipped with a temporary penstock structure sized to control water levels and to protect the initial construction works against overtopping and damage. In the longer term, sufficient freeboard should be maintained to prevent overtopping of the starter embankments until the tailings beaches are established and the decant pool has been pushed back into the basin of the TSF.

It is anticipated that at start-up of the plant and the commencement of tailings deposition there will be water in the RWDD as well as in both sections of the TSF. It is proposed that initial deposition of the tailings and management of the stored water proceed as follows:

- Tailings deposition will commence from the front wall and eastern flank of the TSF, displacing accumulated water towards the central and western sections of the TSF from where make-up water will be pumped to the plant.
- Clean water accumulated in the RWDD will be used as raw water input to the plant.

- Tailings deposition will continue from the front wall of the TSF with selected deposition to the eastern flanks and the upper reaches of the eastern and central fingers. This will promote the displacement of reclaimed and collected water into the western finger of the TSF and maximise the accumulation of water in the fixed decant pool location adjacent to the plant site.

7.1.7 Description of Capital Works for the TSF

The capital works required for the development of the Tulu Kapi TSF are shown in the drawings presented in the design report (see Annexure 7-1). A summary description of the various components of the works is presented below. The estimate of capital costs required for the development of the proposed facility is based on the works as described.

7.1.7.1 Site Clearance

It is envisaged that an average of approximately 200 mm to 300 mm of topsoil will be stripped from the site footprint and stockpiled for use in the rehabilitation process. It is proposed that the stockpiled topsoil be placed immediately adjacent to and up gradient of of the TSF so as to be easily accessible when rehabilitation commences. A box cut of 500 mm will be excavated beneath the footprint of the TSF containment wall.

7.1.7.2 TSF Containment Wall

The TSF will be constructed and operated using a combination of a containment wall and a self-raising methodology. The containment wall will be constructed in phases using selected borrow and mining waste as summarised in Table 7-6. It is expected that this material will be sourced from the mining operations and will be delivered to the wall as part of those operations. Allowance has been made for the shaping and compaction of the material to form the wall as a separate operation which will be carried out in conjunction with the operation of the TSF.

Table 7-6: Summary of Phased Construction of the TSF Containment Wall

Phase	Crest (Tails) Elevation (mamsl)	Storage Capacity (Mt)	Storage Capacity (years)	Duration of Wall Construction (months)	Volume of Wall Construction (m^3)	Rate of Wall Construction (m^3/month)
1	1 620 (1 618)	1.3	1.09	12	403 270	33 600
2	1 626 (1 624)	2.5	2.05	12	381 385	31 700
3	1 641 (1 639)	7.7	6.43	24	1 338 351	55 700
4 (self-raised)	1 654 (1 656)	13.3	11.32	60	N/A	N/A
Total				**48**	**2 123 006**	

It is expected that the construction of the containment wall will commence with the construction of small containment walls across each of the drainage lines within the TSF as shown in Figure 7-8. The purpose of these walls will be to contain flows in the drainage lines and allow them to be diverted past the working areas by means of temporary penstock structures. The penstock intakes will be equipped with side inlets so as to maintain the water levels as low as possible in the early stages of constructing the starter embankments. Once the starter embankments (see Figure 7-9) have some storage capacity, the side inlets can be sealed and small quantities of water can be stored behind the embankments as their construction progresses. Water levels behind the starter embankments can be regulated using the penstock rings until the construction of the starter embankment is complete. Once the TSF is ready to accept tailings, the temporary penstocks will be sealed with concrete plugs.

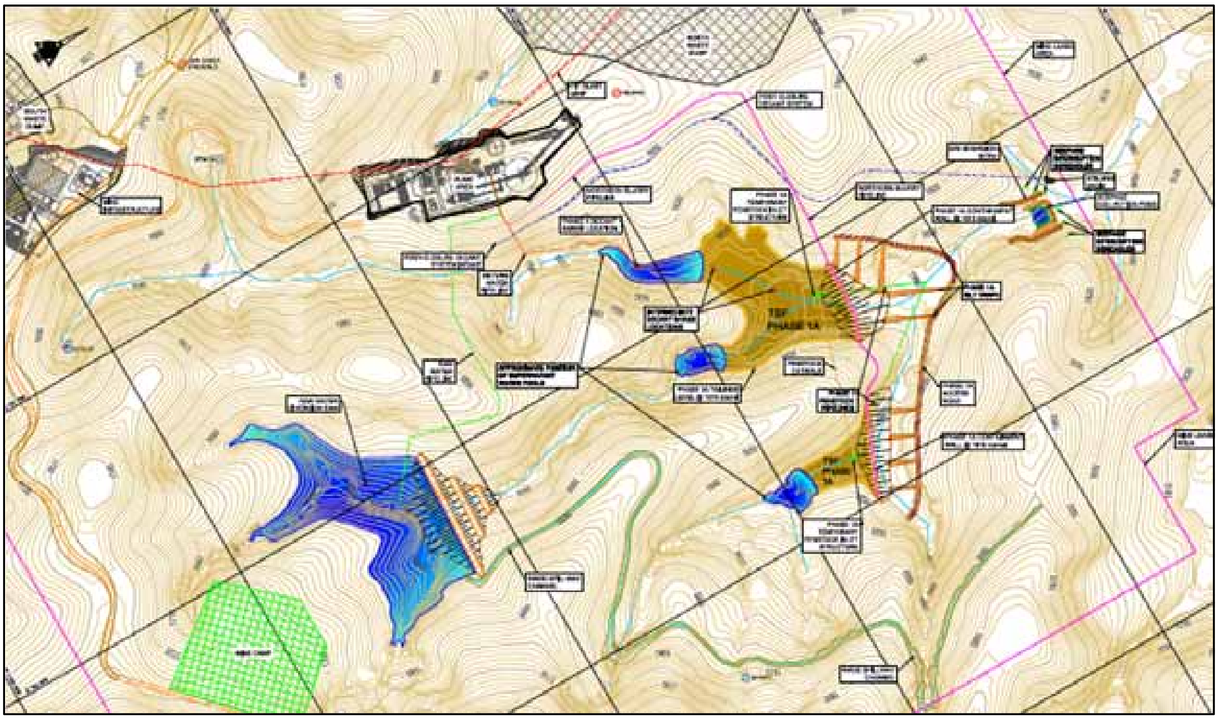

Figure 7-8: Phases 1A and 1B Starter Walls and Temporary Decant Penstocks

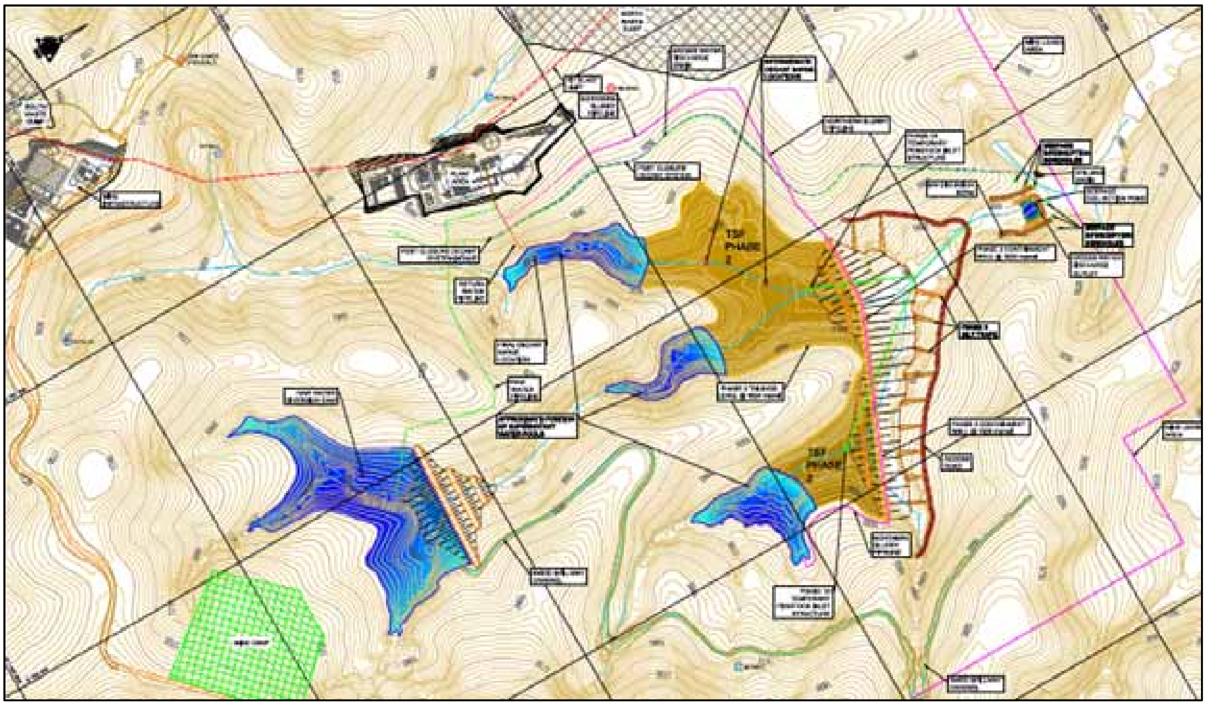

Figure 7-9: Phase 2 Starter Embankment

7.1.7.3 Seepage Control and Groundwater Management

The control of phreatic surfaces within, and seepage from, the TSF is important to ensure its structural stability and also to reduce as far as possible the impacts on the local groundwater environment. It is proposed that this be achieved by

- The ripping and re-compaction of the top 300 mm of the TSF basin to take advantage of the low permeability characteristics of the in-situ foundation materials. The expected hydraulic conductivity of the foundation would be in the range of 10^{-7} m/s when re-compacted.
- The construction of toe, foundation and curtain drains to the TSF starter embankment
- The construction of a seepage collection sump immediately downstream of the TSF into which drain flows can discharge and from which they can be pumped back to the plant water circuit. The expected seepage rate is 2.8 L/s.
- The installation of seepage interception boreholes immediately down gradient of the TSF. Seepage flows captured in these borehole would be pumped to the seepage collection sump from where they could also be returned to the plant water circuit

7.1.7.4 Surface Water Management

The TSF is located in a relatively steep-sided valley which is expected to make the diversion of surface water run-off from the surrounding areas difficult. It is proposed, however, to construct an RWDD up gradient of the TSF cut-off channel to the eastern flank of the TSF to reduce the volume of storm water reporting to the facility. Excess water in the RWDD will be discharged via the RWDD spillway and cut-off channel to the east of the TSF and ultimately into the watercourses downstream of the TSF.

Management of slurry water and storm water run-off to the TSF will be accomplished by ensuring that deposition of tailings is cycled so as to ensure that the tailings beach away from the containment wall and towards the valleys. Excess water in the TSF will be pumped to the plant for use as process water make-up.

A decant barge will be anchored to the shores of the TSF adjacent to the decant pools and below the plant site. The barge will be accessed via a short (< 20 m) floating walkway which will be relocated as necessary together with the barge to follow the decant pool from its initial position towards the starter embankment to its final position adjacent to the plant site.

Decant barges have been preferred to the construction of fixed decant infrastructures in anticipation of the decant pool's rapid movement up the valley. The potential of using fixed decant towers may be reassessed during the detailed design stage of the project.

Construction of the TSF containment wall by the downstream method implies that the outer slopes of the wall would only be rehabilitated at or near closure. During the operational life of the mine it is expected therefore that run-off from the outer slope of the wall would be associated with elevated silt levels. A series of toe paddocks have been placed at the outer toe of each phase of the containment wall construction to assist in settling silt before the run-off is released.

7.1.7.5 Slurry Delivery System

The slurry delivery system to the TSF would comprise 2 160 mm ND PE100 PN12 HDPE overland slurry delivery pipelines and ring feed. The ring feed pipeline will deliver tailings to the perimeter of the TSF and is expected to have offtakes at 50 m centres which will be equipped with movable sections of HDPE spigot pipelines that will be used to spread the deposition of the tailings evenly around the perimeter of the facility. In the latter years of the operation of the TSF, the offtakes will be equipped with the valves and pipes required for construction of the facility as a day wall operation.

7.1.7.6 Decant and Return Water System

The decant and return water system for the TSF is expected to comprise the following:

- Temporary decant penstocks with side inlets to enable the level of water behind the phase 1a and 1b starter embankments to be controlled during construction and prior to the commencement of tailings deposition.
- The decant barge and pump system located in the western basin of the TSF below the plant site. This is expected to simplify the operation of the return water system.

- It is envisaged that the decant barge will be moved progressively up the TSF finger as the tailings beach develops and the decant pool is pushed back from the containment wall. This will progress up to its intended final position adjacent to the plant after which it is expected to be maintained in a relatively constant position by the management of the tailings deposition process.
- TSF return water will be pumped directly from the decant barge to the plant for reuse.
- It is anticipated that during the rainy season, the entire plant water requirement could be supplied from the decanted slurry water and storm water run-off from the site. The return water pumping system should be sized accordingly. It is expected also that the recovery of water from the facility may be significantly enhanced by the recovery of water from the seepage interception boreholes. The return water pumping systems should be sized accordingly.

7.1.7.7 Low Permeability Soil Liner

Laboratory hydraulic conductivity tests were performed on 11 representative soil samples at Tulu Kapi. Five samples were obtained from test pits that represent the upper 0 to 2 m of soil and six samples were from depths of 3 m to 5 m. The soils in the upper 2 m had hydraulic conductivity tests that ranged from 5×10^{-6} cm/s to 1×10^{-6} cm/s. The deeper samples (> 2 m) exhibited lower hydraulic conductivities that ranged from 4.3×10^{-6} cm/s to 8×10^{-8} cm/s. The site soils naturally exhibit low hydraulic conductivity, which is favourable for serving as a barrier to constituents in the tailings. An engineered low permeability soil liner will be constructed in the TSF by reworking, moisture conditioning, and re-compacting the site soils as described below.

7.1.7.7.1 Site Preparation

The initial stages of the work will involve site preparation which includes clearing and grubbing to remove the vegetation and roots and then stripping and stockpiling of topsoil. This procedure should be completed in stages to minimise the potential for erosion by limiting the construction area within the TSF to the areas that will come into contact with the tailings at each of the four phases of TSF development.

7.1.7.7.2 Construction of Low-Permeability Soil Liner

On completion of the topsoil stripping, the exposed surface should be evaluated for suitability as an in-situ low-permeability soil liner. Once approved by the engineer, the surface should be scarified to a depth of 300 mm to break up any preferential flow channels caused by roots, worm, or rodent borrows. The soil should be moisture conditioned and re-compacted in place to achieve 95 % Standard Proctor at -2 % to +4 % of optimum moisture content. If the TSF dam construction material meets the requirements of the compacted soil liner, no additional soil liner will be required on the interior dam face. The resultant low-permeability soil liner will exhibit a hydraulic conductivity no greater than 5×10^{-6} cm/s.

Some areas will not be suitable for in-situ re-compaction as soil liners, i.e. those areas that consist of either rock or sandy soil. In these areas, acceptable soil liner material will have to be imported and placed in a 300 mm thick lift, moisture conditioned and subsequently compacted to 95 % Standard Proctor between -2 % to +4 % optimum moisture content.

The final soil liner will be a minimum 300 mm thick low-permeability compacted soil layer which is continuous over the entire footprint of the TSF that will be in contact with the tailings.

The exception is the soil liner in the mine areas that require backfill of pits, where a minimum low-permeability soil liner of 1 m is required. This additional thickness of the soil liner will accommodate the future settlement anticipated to occur over the backfilled pits and shafts. Acceptable low-permeability soil liner material is classified as CL, CH, MH, or ML-CL according to the Unified Soil Classification System (USCS).

7.1.7.8 Access Control and Safety

It is expected that all the current residents of the project site will be relocated prior to the commencement of construction. It is suggested that consideration be given to the installation of a barrier (either stock fence or vegetative barrier) and warning signage at the perimeter of the TSF and RWDD.

Access to the temporary penstocks will be via walls and penstock catwalks constructed and operated in accordance with accepted safety standards. Access to the decant barges will be via floating walkways supplied and installed with the decant barges. The walkways and barges will be equipped with handrails and lifting equipment to ensure the safety of operational and maintenance personnel.

7.1.8 Description of Operating and Closure Works

The works associated with the operation and closure of the TSF are summarised below to provide context to the estimate of the associated costs. They are described separately as their cost structures will be different.

7.1.8.1 TSF Operation

The TSF will be operated as a containment facility constructed as a series of downstream wall raises using fill material imported from the mining and pre-stripping operations. Routine operation of the facility will include management, supervision, labour, equipment, and materials required for the following:

- Construction of the downstream wall lifts well in advance of the deposition of tailings so as to maintain adequate freeboard.
- Operation of the slurry delivery system to ensure control of the depth and position of the decant pool to enable the operation of the decant barge and pump system.

- Construction of the silt traps to the outer toe of the advancing downstream embankment. The silt traps should also be cleaned out or raised as necessary should they be filled.
- Operation, maintenance, and monitoring of the seepage collection boreholes and pumps.
- Routine inspections and maintenance of the facility and associated infrastructure.

In the latter years of the operation of the facility, it will be self-raised by means of the day wall method of construction. During this phase of the operation, the wall will be lifted and constructed using dried tailings.

It is expected that the operation of the TSF will be managed and supervised as part of the operation of the process plant. The costs associated with the construction of the downstream lifts to the containment wall have been itemised separately based on estimated unit rates for the processing of material delivered to the wall by the mining contractor.

The operating cost estimate presented includes provision for quarterly inspections of the facility by a suitably qualified person and the compilation of an annual report on the construction and operation of the facility. The focus of the quarterly inspections and annual reporting on the facility will be to ensure that

- The facility is being constructed and operated in accordance with the design requirements
- Seepage and slope stability models of the facility are periodically reviewed and updated
- Monitoring information relevant to the TSF is collected and analysed. Information is expected to be collected as part of the overall environmental management function for the mine and should include the following:

    - Collection and analysis of groundwater samples from within and down gradient of the TSF
    - Collection and analysis of surface water samples from the seepage collection sump and the storm water control dam
    - Collection and analysis of dust samples from up and down wind of the TSF

- The validity of the assumptions underlying the design is confirmed and the necessary adjustments are made should this not be the case. Specific attention will be paid to the following:

    - The settling and consolidation characteristics of the tailings materials
    - The geotechnical characteristics of the TSF foundations
    - The collection and abstraction of seepage from the facility
    - The quality of surface water within and outside of the TSF system
    - Ensuring safe working practices by the operator
    - The control of access to the facility

- Ongoing rehabilitation of the facility is kept up to date and that routine maintenance activities are carried out by the operator including cleaning out of the silt traps, clearing slimes spillages, repair to storm water containment and diversion structures

7.1.8.2 Rehabilitation and Closure

The development of a conceptual rehabilitation and closure plan and implementation strategy for the facility has taken place in the context of the proposed post-closure land use for the areas disturbed by mining and related activities and the key environmental issues as identified during the EIA process. It is intended that the rehabilitation and closure process will take place progressively as the facility is developed.

Rehabilitation and closure works that will take place concurrently with the construction and operating phases will include

- The stripping and stockpiling of topsoil from the site for use in the rehabilitation and closure process
- The construction of the slopes of the facility with slopes of 1 in 3 or flatter to facilitate their covering and the re-establishment of vegetation
- The placement of a soil and rock cover and vegetation to the outer slopes of the containment wall once the final lift is complete
- The construction of a post-closure penstock decant system. This decant system will control water in the dam by acting as a soak away system during normal rainfall events. In the event of heavy rainfall, the penstock will decant large volumes of water so as to prevent the pool from breaching the freeboard requirement

It is expected that decommissioning, rehabilitation and closure of the facility at the cessation of operations will include

- The removal of the slurry delivery and return water pipelines and all associated support works
- The upgrading of the containment wall(s) to ensure the long-term containment of surface water run-off to the facility
- The construction of contoured surface water control berms to prevent the accumulation of all run-off in the lower lying areas on top of the facility, thereby maximising seepage and evaporation losses
- The placement of drainage, moisture retention, and topsoil cover to the top surface of the facility and the establishment of selected indigenous grass and tree species on the area

Aftercare and maintenance of the site is expected to comprise the repair of localised erosion gulleys and the maintenance of vegetation for a period of three to five years after completion of the rehabilitation and closure works described above. Monitoring of surface and groundwater quality in the area is likely to be required to continue for a period of up to 30 years.

7.1.9 Estimates of Capital, Operating, Closure and Aftercare Costs

Estimates of the costs associated with the development, operation, and closure of the Tulu Kapi TSF have been compiled based on the proposed site development strategy, the anticipated rates of tailings deposition, and the life of mine as described in Annexure 7-1.

7.1.9.1 Capital Costs

Summaries of the capital cost estimates for the phased development of the TSF over the 13-year life of mine are presented in Table 7-7 inclusive of provisions for the Contractor's Preliminary and General Costs at 25 % of the value of the measured works and a Contingency at 10 % of the measured works. It is estimated that the cost of establishing the Tulu Kapi TSF will be US$6.575M. The ongoing development of the TSF will require the following expenditure:

- An additional US$10.58M by the end of Year 2 of the life of mine
- An additional US$5.467M in Years 3 to 6 of the life of mine

Both the initial and ongoing capital expenditure are dominated by the cost of constructing the downstream wall lifts to the TSF containment wall. It must be noted that the estimates of those costs exclude the cost of sourcing the necessary materials which is assumed will be supplied to the site of the wall free of charge by the mining contractor.

Table 7-7: Summary of Estimated Capital Expenditure

Scope of Work	Phase 1A (US$M)	Phase 1B (US$M)	Phase 2 (US$M)	Phase 3 (US$M)	Phase 4 (US$M)	Total (US$M)
Site Clearance and Topsoil Stripping	0.421	0.265	0.364	0.752	0.111	1.914
Construction of Starter Embankment and Containment Walls	0.815	1.217	2.143	6.944	0.034	11.167
Starter Embankment and Containment Wall Drainage	0.966	0.054				1.021
Temporary Penstock Decant System	1.812					1.812
Slurry Delivery System (Provided for under Plant Costs)						
RWDD and Associated Infrastructure						
Seepage Collection and Sediment Control	0.332	0.061	0.074	0.021	0.021	0.509
Post-Closure Decant System	0.0120			0.039	0.119	0.171

Scope of Work	Phase 1A	Phase 1B	Phase 2	Phase 3	Phase 4	Total
	(US$M)	(US$M)	(US$M)	(US$M)	(US$M)	(US$M)
Miscellaneous	0.652					0.652
Subtotal: Measured	5.012	1.598	2.581	7.757	0.286	17.234
Design & Engineering	0.197					0.197
Contractor's P&G Costs	1.253	0.399	0.645	1.939	0.071	4.307
Contingencies	0.626	0.199	0.322	0.969	0.035	2.154
TOTAL	**7.088**	**2.196**	**3.548**	**10.665**	**0.392**	**23.889**

7.1.9.2 Operating Costs

The cost of operating the TSF has not been estimated based on the assumption that the operation and management of the facility will be carried out by the metallurgical plant staff. Apart from the ongoing construction of the containment walls, as described above, the costs associated with the operation of the TSF are expected to comprise the cost of establishing and maintaining on site the supervision, labour and equipment required to

- Operate the slurry delivery and return water systems (priced as part of the operation of the plant)
- Manage and supervise the ongoing construction of the downstream wall raises
- Construct the self-raised portion of the TSF in Years 7 to 13

7.1.9.3 Rehabilitation and Closure Costs

The costs of rehabilitation and closure of the TSF have been estimated in present day values based on its expected configurations at closure and the closure methodology as described.

It is estimated that the rehabilitation and closure costs for the Tulu Kapi TSF will be US$8.448M as summarised in Table 7-8. The estimated costs include provision for the Contractor’s Preliminary and General Costs at 25 % a Contingency at 10 % of the value of the measured works and exclude provisions for

- Post-closure collection and treatment of groundwater
- Environmental monitoring, which is assumed to be included under the overall environmental management budget for the mine.

The estimated costs are significantly higher than normal and are a function of the expected need to construct an engineered drainage layer and moisture retention cover to the TSF to eliminate post-closure recharge to the facility in order to counter the potential for Acid Mine Drainage generation.

Table 7-8: Summary of Estimated Rehabilitation and Closure Expenditure

Item No.	Description	Unit	TSF Slopes (11 ha)	Crest of TSF (57 ha)
1	Source, load, haul and place 0.5 m thick drainage layer to surface of TSF	US$7.5/m^3		2.138
2	Source, load, haul and place moisture 0.50 m thick moisture retention cover layer to TSF	US$7.5/m^3		2.138
3	Recover from stockpile, load, haul and place 0.3 m layer of topsoil to TSF	US$8.00/m^3	0.264	1.368
4	Vegetation establishment to sloped areas	US$0.5/m^2	0.055	0.143
5	Vegetation establishment to flat areas			
	Subtotal: Rehabilitation and Closure Works	US$M	**0.319**	**5.786**
	Aftercare and maintenance of civil works as % of value of the works	2 %	0.01	0.113
	Aftercare and maintenance of vegetation establishment as % of the value of the works	20%	0.11	0.029
	Subtotal: Rehabilitation, closure, maintenance and aftercare	US$M	0.335	5.927
	Contingencies as % of the value of the works	10%	0.034	0.592
	Contractors Preliminary and General Costs as % of the value of the works	25%	0.080	1.480
	Total Cost of Rehabilitation and Closure	US$M	0.449	7.999
		$m/ha	0.041	0.140

7.1.9.4 Engineering Design and Monitoring Costs

The estimate of life of mine expenditure for the TSF includes provisions for engineering design and construction and operational supervision as follows:

- Engineering design and construction supervision at 3 % of the estimated capital and rehabilitation and closure costs
- Bi-annual inspections of the operation of the TSF is included at US$10k/a
- Annual inspection of the facility and compilation of an annual report is included at US$20k/a
- Annual inspection and reports on the closure works at US$20k/a

7.1.10 Conclusions and Recommendations

7.1.10.1 Conclusions

Based on the definitive feasibility design of the TSF as described it is concluded that

- The preferred site for the development of the Tulu Kapi TSF is in an area immediately adjacent to and to the east of the proposed plant site. The site will be developed as an impoundment facility with staged downstream wall lifts to match the anticipated deposition of 1 200 ktpa of gold tailings for a period of 6 years, after which the facility will be self-raised as a day wall facility for a further 7 years.
- The geotechnical conditions on the proposed sites of the TSF are considered suitable for the establishment of the facility. Material is expected to be available from the mine for the construction of the containment embankments.
- The site is located in an area of relatively high rainfall which requires that the catchment reporting to the TSF be minimised by the construction of surface water run-off diversion channels and flood attenuation dams.
- The TSF has been classified as a Medium Hazard Facility due to the remoteness of its location, the absence of downstream infrastructure, and the proposed method of construction.
- Based on the assessment of the tailings geochemistry there is some uncertainty with respect to the potential for surface and groundwater contamination associated with the TSF. Given this uncertainty, a precautionary approach has been taken in the design of the facility. It is intended to contain all surface run-off emanating from the facility and to incorporate into the construction and operation of the facility measures to limit as far as possible the migration of seepage. These measures include the following:

    - The ripping and re-compaction of the TSF footprint to take advantage of the low-permeability soils underlying the facility to slow the rate of seepage to the foundation and encourage the collection of seepage in the toe drainage system.
    - The installation of a series of seepage interception boreholes immediately down gradient of the TSF to intercept potentially contaminated groundwater flows which would be pumped to a seepage collection sump.
    - The installation of a seepage collection sump and return water pump system at the toe of the TSF to collect drain flows and to accept water pumped from the seepage interception boreholes and return it to the TSF decant pool for use as process water in the plant.

- The estimated life of mine costs for the development, operation and closure of the TSF have taken cognisance of the following:

    - The topography of the project site and the proposed tailings deposition rate, which favour the construction of a containment facility for the storage of tailings in the first

6 years of the operation, after which self-raising for the remaining 7 years of the life of mine is possible.
- o The remoteness of the site which is expected to affect earthworks and material supply rates.
- o The potential need for an engineered cover to the TSF at closure to prevent infiltration of rainfall and subsequent seepage thereby reducing the mobility of potential contaminants within the TSF.
- o The costs have been based on schedules of quantities to which unit rates have been sourced from contractors.

7.1.11 Recommendations

Based on the design and supporting information available at the time of completing the updated DFS design and the updated life of mine plan, it is recommended that the subsequent phases of the project include the implementation of the measures identified for the pro-active mitigation of surface and groundwater contamination risks. These are in accordance with the precautionary principle as well as currently accepted practice and are expected to include, but not necessarily be limited to the following:

- The use of the in-situ materials beneath the TSF footprint to construct a layer of re-compacted low permeability clayey soils to reduce the rates of seepage to the foundation of the facility
- The installation of a series of groundwater interception boreholes down gradient of the TSF to intercept and abstract potentially contaminated flow, to be returned to the plant or the TSF decant pool as process make-up water inputs
- The design and construction of a passive treatment system to the downstream water course to treat post closure seepage flows and run-off from the TSF
- The construction of an engineered cover to the crest of the TSF to reduce the rate of recharge to the facility, thereby reducing the mobility of potential contaminants within the facility
- The construction of a post-closure decant system that will decant general monthly rainfall water and will provide a large decant capacity in an extreme storm event

The implementation of the mitigation measures as described should be finalised in conjunction with the finalisation of the assessment of the tailings geochemistry, expected to include the following:

- Confirmation of the geochemical properties of the tailings with specific reference to the potential for AMD generation and leachability of contaminants as per the recommendations of the preliminary geochemistry assessment
- Confirmation of the potential severity of groundwater contamination due to contaminated seepage from the TSF, based on the geochemical characterisation of the tailings and the outcome of the geohydrological assessment and associated contaminant transportation modelling

- Confirmation of the geotechnical properties of the tailings based on laboratory testing of a representative sample
- Confirmation of the availability of material from the open pit suitable for the construction of the starter embankment and subsequent raises to the containment wall

Once the additional information is available, it is recommended that the detailed design of the TSF be finalised to include a detailed review of the pollution control measures and, specifically, the requirements for closure of the TSF. The finalisation of the TSF design should include the development of the necessary codes of practice and operating manuals to ensure the appropriate management and operation of the facility.

It is recommended that rates for the construction of the capital and rehabilitation and closure works be sourced either from suitably equipped and qualified local contractors or from international contractors with the capacity to carry out such works in Ethiopia.

Should the project proceed to implementation, it is recommended that the financial provisions for the development, operation and closure of the TSF be confirmed to include appropriate allowances for

- The ongoing and final rehabilitation and closure of the facility
- Monitoring of the quality of surface water both within the TSF system and in the diversion works to ensure that potential contamination of surface water outside of the TSF system is detected
- Monitoring of the management of the return water system to ensure that it is operated in accordance with the intended philosophy of minimising storage in the TSF itself while maintaining sufficient storage to provide for ongoing plant make-up water requirements
- Monitoring of the extent and quality of groundwater seepage emanating from the TSF site and its abstraction, if necessary, by means of dewatering boreholes

7.1.12 Bibliography

Golder Associates. (2012). Tulu Kapi Gold Project MIne Infrastructure Geotechnical Report.
Golder Associates. (2012). Tulu Kapi Mine : Preliminary Geochemistry Assessment Report.
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Harck, T. (May 2012). Memorandum on Tulu Kapi Static Tests.

7.2 RECLAIM WATER CONVEYANCE INFRASTRUCTURE/TAILINGS

The Tulu Kapi tailings will be transported from the processing plant to the adjacent TSF as conventional settling slurry (a solids content by mass of ~ 40 %). The tailings will be deposited in the TSF through an open-ended pipe spigot distribution system. The tailings will settle out in the TSF and the supernatant water will be pumped from the TSF directly to the processing plant for use as process water.

Additionally, raw water will be pumped from the RWDD located in the same watershed as the TSF to the raw water tank at the processing plant. This system will consist of a pump and pipeline and will be separate from the tailings conveyance and return water system. The water block flow model diagram is shown in Figure 7-10.

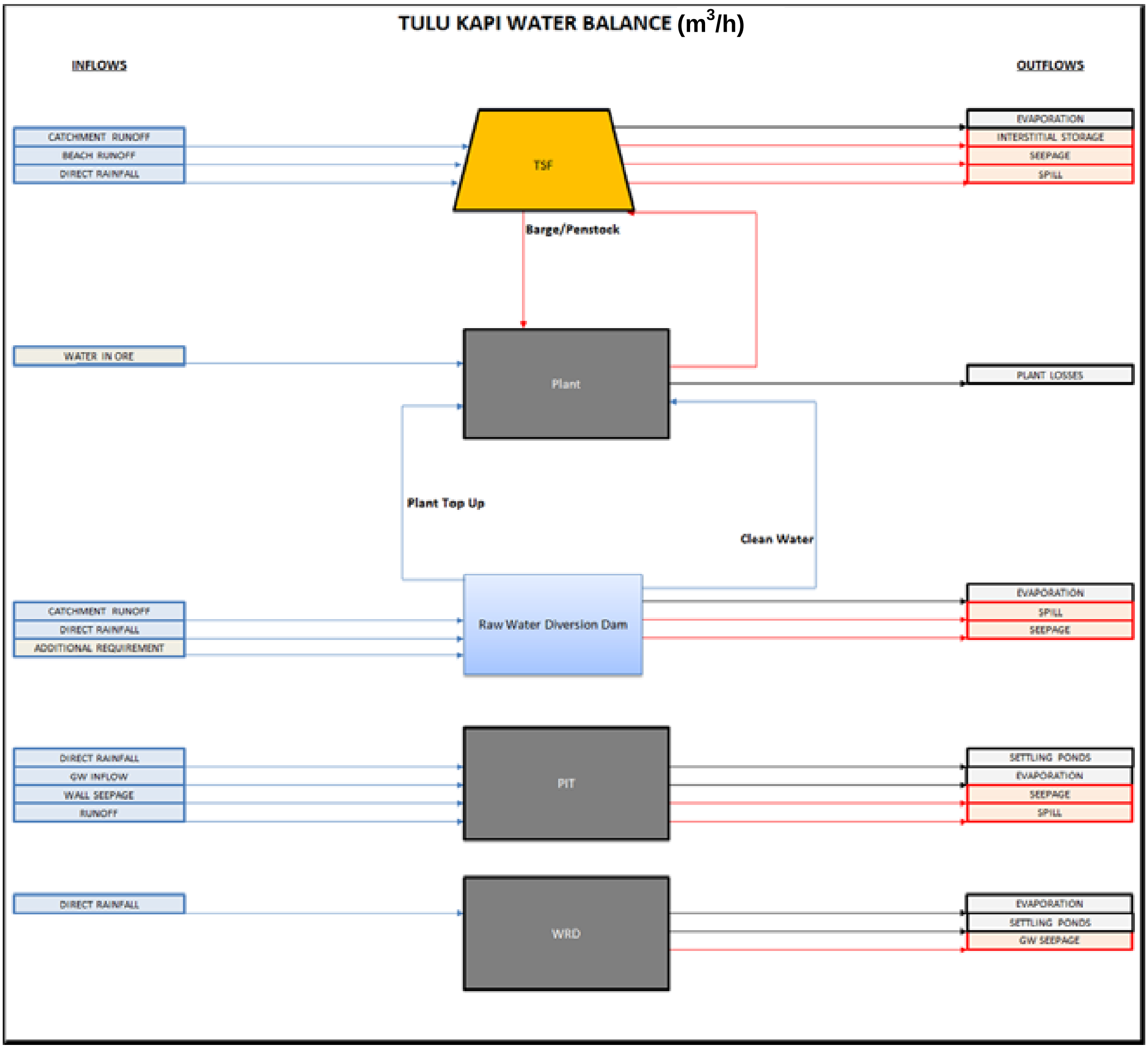

Figure 7-10: Water Block Flow Model Diagram

7.2.1.1 Basis of Design

7.2.1.1.1 Design Flows

The tailings and reclaim water conveyance systems were designed for the flows given in Table 7-9 and Table 7-10.

Table 7-9: Average and peak design flows for tailings pipeline system

Stream No.	Pipeline System	Average Tonnages (t/a)	Average Operating Hours (h/d)	Peak/ Instantaneous Design tonnage (t/h)	Peak Operating Hours (h/d)
1	Process Plant Final Tailings Tank to TSF	1 200 00	21.9	2790.0	24.0

Table 7-10: Average and Peak Design Flows for Reclaim Pipeline systems

Stream No.	Pipeline System	Average Flow (m^3/month)	Average Instantaneous Design Flow (m^3/h)	Average Operating Hours (h/d)	Peak/ Instantaneous Design Flow (m^3/h)	Peak Operating Hours (h/d)
2A	TSF Return Water Barge to Plant Process Water Pond	177 410	243	24	243	24
3	RWDD Barge to Plant Raw Water Pond	196 390	269	24	269	24

7.2.1.1.2 Design Approach and Assumptions

The Definitive Feasibility Design engineering incorporates the following design approach:

- Proposed pipeline routes for the proposed pipeline systems were selected according to the shortest and most practical route, taking cognisance of existing servitudes, ease of construction and economics.
- For the purpose of this study, elevations were extracted from the 0.5 m LIDAR-generated contours (2012) and were plotted against respective changes for the different pipe routes to determine the anticipated ground profiles.
- Water Hydraulic calculations were performed using the Hazen Williams equations.

- Tailings Hydraulic/Rheological calculations were performed incorporating the following theories:

    - McElvain & Cave chart for deposition velocity calculations
    - Govier and Aziz equations for the laminar flow determinations
    - Wasp equations for mixed regime slurrie

- The selection of the pipeline diameter for each pipeline system was made using good life cycle cost principals. The following approach was taken for the calculation of the life cycle cost:

    - Pump selections were made for the selected pipeline diameter and the power absorbed by the pump(s) was extracted from the pump selection programme.
    - Supply rates for pipelines were obtained from the pipeline suppliers "Gazelle Plastics" and they are discounted rates.
    - Supply rates for pumps were based on quotations received from the pump suppliers "ITT Pumps" and "Warman Pumps". An estimated allowance has been made for the motors, pump base plates, valves and fittings, and installation.
    - The capital expenditure costs for the electrical motor control panels, bulk supply and substation infrastructure were estimated for the study.
    - The present value of the operational and maintenance (O&M) costs is based on the annual costs with 5 % interest and 2.5 % escalation over a 10-year analysis period.
    - The baseline electricity cost for the life cycle cost analysis was set at US$0.0217/kW.
    - Motors for the pumps were sized for 400 V and 50 Hz using a utilisation factor of 0.8.
    - The majority of the new pipelines will be constructed with HDPE piping and will predominantly be installed on the surface and only be buried where they need to cross a road. The HDPE piping will be covered by soil to protect them against the risk of fire.
    - The end suction pump stations were positioned to maximise the available net positive suction head (NPSH) for the pumps by keeping the suction lines as short as possible. This in turn will minimise and avoid cavitation within the suction of the pump.
    - Other aspects considered in the layout of the pump station included theft control, geotechnical, emergency drainage and access aspects, etc. The pump station, transformer bays and access roads were positioned to allow reasonable access for delivery of the pumps and transformers.
    - Details for the selected pumps were obtained from Xylem Pumps and Weir Minerals Pumps in Johannesburg. The pump selections were made based on technical information received from the suppliers. This will have to be optimised during the future design stages of the project.
    - The use of standby generators in the event of power failure has not been considered.

7.2.1.2 Control and Operating Philosophy

7.2.1.2.1 Pump Stations and Control Rooms

The pumps, motor control centres (MCCs) and other electrical equipment for reclaim/barge pump stations will be installed as all-weather equipment. The MCC equipment for the tailings pump station will be installed in an MCC Building provided by the mine at the process plant. The pumps and motors for the tailings pump station will be installed as all-weather equipment and no allowance for a pump station building was made under the Tailings Pump Station.

The pump stations will be designed to operate semi-automatically without full-time operator attendance. The status of the pumps and the system will be reported to the Control Centre via an integrated control system. Skilled operators and maintenance staff will be required for the pump stations.

Should the status report indicate attendance required at the station, the control room operator will inform the operator. Pressure and flow together with valve and pump status will be monitored and reported. The valve status, system flows, and reservoir levels will be monitored as required input to the pump station's operation. Fault notification and operating requirements will be SCADA controlled from a Control Centre. During a complete power failure, the control valves will be allowed to close as a safety precaution against pipeline draining. After the power has been restored, resetting of the system to operational status by the operator will restart the system.

Apart from the tailings delivery pump system, all pumping systems will pump via duty pump(s) in parallel with one automatic start standby pump/pump train in parallel to achieve the minimum availability of approximately 92 %, based on 8 000 operating hours per annum. The tailings delivery pump system will not have an automatic start standby system and will rely on the final tailings tank to gravity flow tailings to the nearest outlet spigot in the TSF during times of pump outage. Spare tailings pumps need to be kept at the mine if deemed necessary by mine management.

7.2.1.2.2 Pipeline and Control Equipment

The following pipeline and control equipment is required:

- Air valves and their chambers are required on specified high points on the reclaim water pipelines. These air valves are automatic, double-acting air valves with anti-shock. All the required pipe fittings in the air valve chambers shall be manufactured from 316L SS to reduce the likelihood of corrosion.
- Scour valves are required on specified low points on all reclaim water pipelines.
- These scour valves should be operated manually and only be opened while bleeding/cleaning the pipelines. All the required pipe fittings in the scour valve chambers shall be manufactured from 316L SS to reduce the likelihood of corrosion.

- At the start of each pipeline, a flow switch will be required to switch off pumps should the valves be closed at the delivery end of the pipeline.
- Level/altitude sensors will be installed at all the suction and discharge ponds and tanks which will control the pumps. The level sensors will be linked to the control valves and pumps via control cables. Backup level sensors will be installed with the primary level sensors. In the event that the primary level sensors fail, the backup sensors will be used. A noticeable difference in the readings from the primary and backup sensors will indicate failure of one of the level sensor systems and will require the repair of the faulty sensor(s).

7.2.1.2.3 Cleaning Provisions on Return Water Pipelines

There is some uncertainty about the exact scaling potential in the return water pipeline, however, it is not considered justifiable at this stage to allow additional permanent pigging infrastructure for the likelihood of scaling in the pipeline. The scaling potential in the pipeline should be monitored during early operation to ensure that necessary measures are taken so that it does not become problematic.

7.2.2 Tailings Characterisation

Tailings characterisation was finalised in accordance with the rheological data for both the fresh and the oxide representative samples (see Table 7-11).

Table 7-11: Tailings Characterisation

Parameter	Value	Source/Notes
Specific gravity (SG) of solids	2.8	Note 1
Particle size distribution	D10 / D30 / D50 / D60 / D80 (µm) 8 / 29 / 59 / 82 / 155	Note 2
Solids concentration	40 % Cw	Note 3
Viscosity	0.0540 Pa.s	Note 4
Yield stress	0	Note 5

Note 1: Values received from SENET (AMMTEC-NYO-A12931-PrelimVariability-FULL REPORT)
Note 2: Values received from SENET for cyclone overflow slurry that will also be the TSF feed PSD. This matches the simulated values.
Note 3: Values from the Design Criteria received from SENET
Note 4: Viscosity Test results received from SENET on oxide ore composite for P_{80} :150 µm
Note 5: Tailings samples resembled no yield stress

7.2.3 Tailings Conveyance Systems

7.2.3.1 Battery Limits

The tailings transfer pipelines begin at the outlet flange of the final tailings tank (by others) that feed the tailings transfer pumps. Tank controls will be integrated into the pipeline control system for smooth system operation. The tailings transfer pipeline is assumed to end at the edge of the tailings storage facility where it ties into the tailings distribution pipeline. The tailings transfer pipeline and distribution pipeline are combined only for the hydraulic analysis and costing.

It is assumed that electrical power and motor control units will be provided by others to the tailings transfer pumps and ancillary equipment. Communication and electrical wiring are assumed to be by others. Fibre optic cable from the tailings pumps to the tailings dam has been excluded.

The tailings pump station is assumed be a flat graded site as part of the process plant site preparation plan. Golder's scope is assumed to start with the concrete foundations. The site is assumed to be of competent material, with no extravagant foundation design (such as pile support) required. Concrete and rebar, pump pedestals, pipe supports and structural steel quantities are included in the costing. The pipeline is assumed to sit on concrete sleepers with thrust blocks where required for the entire length.

7.2.3.2 Control and Operating Philosophy

7.2.3.2.1 Final Tailings Tank

The tailings from the CIL/detoxification circuit will flow into the final tailings tank. A flush water supply will feed the final tailings tank for flushing operation. Concentration control to ensure that the tailings solids concentration does not go higher than 40 % Cw is assumed to be dealt with prior to the final tailings tank by others. The final tailings tank should allow for a three-minute buffer to allow for small process disruptions.

The final tailings tank will feed one pump train consisting of two pumps in series. The operating level in the final tailings tank will generally be maintained by pump speed. As the level in the final tailings tank rises, pumps will increase the flow rate by speeding up. As the level in the tank drops, pumps can decrease the flow rate by slowing down as long as the minimum pipeline velocity is maintained. If the minimum pipeline velocity cannot be maintained, more dilution water from the CIL/detoxification circuit (or flush water) should be added.

A flush water connection to the final tailings tank will allow for continued pipeline operation during disruptions in tailings production. Pipeline transport must be performed at a minimum flow rate; if slurry cannot be provided at this flow rate, flush water must be introduced until slurry production can resume.

7.2.3.2.2 Start-ups

Pumps should be started on water when possible. Normal start-up should utilise the flush water connection to the final tailings tank until the water has pumped through the last pump. Then slurry can be introduced and pump speeds and dilution water control will adjust automatically to maintain the tank level and proper transport concentration.

7.2.3.2.3 Shutdowns

During a shutdown, tailings flow into the final tailings tank should be stopped and flush water should be introduced. The entire pipeline should be flushed with water prior to shut-down. A procedure will be developed in later phases to slow the pumps and shut in the pipeline for restart.

7.2.3.2.4 Normal Operation

Normal operation will consist of slurry concentration control (prior to the final tailings tank by others), and final tailings tank level control. The final tailings tank level must be controlled by either adding or limiting dilution water to the final tailings tank, and varying the pump flow rate accordingly. A density meter in the discharge pipeline will provide instant feedback to a dilution control valve that feeds the final tailings tank. Concentration control will be set by operators and the system will automatically add/reduce dilution water as needed to maintain the set point. Flow rate will be measured by a flow meter in the discharge pipeline and pump speeds will be varied by a control loop tied to the final tailings tank level.

A more detailed control scheme for the pump train will be developed in the next phase of engineering. As slurry concentration and throughput changes, pumps will be sped up/down and brought on/off as required to maintain pipeline transport within the operating range. If pipeline flow drops to the minimum level, dilution water will automatically be added to the final tailings tank to ensure that the pipeline does not operate at too low a velocity. Steady-state operation will occur when tailings inflow is at a constant flow rate and concentration. Slurry can be pumped at steady state at any point in the operating range.

7.2.3.2.5 Gland Seal Pump Operation

Each mainline pump has its own dedicated gland seal supply pump. Gland seal pumps are identical positive displacement pumps. Main line pumps should never be run without gland seal water. Gland seal water pumps will be started before mainline pumps are started, and shut off after mainline pumps are shut off. If a gland seal pump fails, the automated control system will shut down its corresponding pump immediately and the operator will be notified to shut down the entire pump train and switch to the standby train. Gland seal pump infrastructure is assumed to be outside Golder's battery limit.

7.2.3.2.6 Abnormal Operation

Abnormal operation consists of emergency shutdowns, slurry supply outside of transport requirements, leak detection, and overpressure.

- **Emergency Shutdown**

  As far as possible, a shutdown should follow normal shutdown procedures, where slurry inflow into the final tailings tank is stopped and water is allowed to flush the pipeline completely. When this procedure cannot be completed, the pump train should be shutdown, isolated, and automatically switched to a short-term flow from the return water pipeline to assist flushing of the mostly downslope pipe. A procedure will be developed in later phases to shut in the pipeline where necessary. The cause of shutdown should then be determined in the pump train.

- **Slurry Supply Outside of Transport Requirements**

  If slurry is supplied at too high of a concentration, dilution water will be added until the concentration is within acceptable levels. If slurry is supplied at too low of a concentration, pumps must increase flow rate to acceptable levels for transport velocity, or the system must be shut down and the thickeners must re-circulate until density is within acceptable levels.

- **Leak Detection**

  A flow meter has been provided at the discharge of the pumps and at the outlet of the transport pipeline where it ties into the distribution pipeline. During steady-state operation, the flow meter readings will be similar, within the allowed uncertainty of measurement. If a leak were to develop, flow and pressure deviations between inlet and outlet would indicate this. In this event, operators would be notified and the system would automatically shut down.

- **Pipeline Overpressure**

  The pressure at the transition between steel and HDPE must be maintained below the pressure rating of the HDPE. The pipeline is designed to be able to handle different concentrations and flow rates, but operation outside of the design range could potentially risk overpressuring the pipe. The pressure indicating transmitter that is used for leak detection will also transmit operating pressures, and pumps will be slowed or shut down as needed to ensure that there is no overpressure of the pipeline. All other locations along the pipeline are safe from overpressure by the maximum allowable operating pressure (MAOP) of the materials and equipment.

7.2.3.3 Process Plant Tailings Tank to TSF (Northern Section Pipeline)

7.2.3.3.1 Pipeline Route

The proposed route for the Northern Section pumping main runs from the Tulu Kapi process plant final tailings tank to the Tulu Kapi TSF Northern Section. The layout of the proposed pipeline route is shown in Figure 7-11.

From the longitudinal ground profile, the following can be observed:

- The entire pipeline route length is 2 902 m
- The invert level of the pipeline at the pump station is 1 664.1 m
- The pipe invert at the discharge point is 1 643.5 m
- The maximum static head difference between the start and end point is -21.562 m
- The highest NGL point along the pipeline route is 1 668 m at chainage 801 m
- The lowest NGL point along the pipeline route is 1 643.5 m at chainage 2 902 m

7.2.3.3.2 Basic Design Criteria for the Pipeline

From the basis of design, the following flows are given from the Tulu Kapi process plant final tailings tank to Tulu Kapi TSF. The tailings characterisation was finalised as concentration by weight was maximised to no higher than 40 % Cw for the purposes of this study. Tailings design throughput parameters are shown in Table 7-12.

Table 7-12: Tailings Design Throughput Parameters

Parameter	Value	Source/Notes
Solids SG	2.8	Note 6
Dry tonnage throughput	250 tph	Note 7
Flow rate	465 m^3/h	Note 8
Note 1: Input received from SENET (AMMTEC-NYO-A12931-PrelimVariability-FULL REPORT) Note 2: Tailings throughput of 2 000 000 tpa, with 92 % availability		

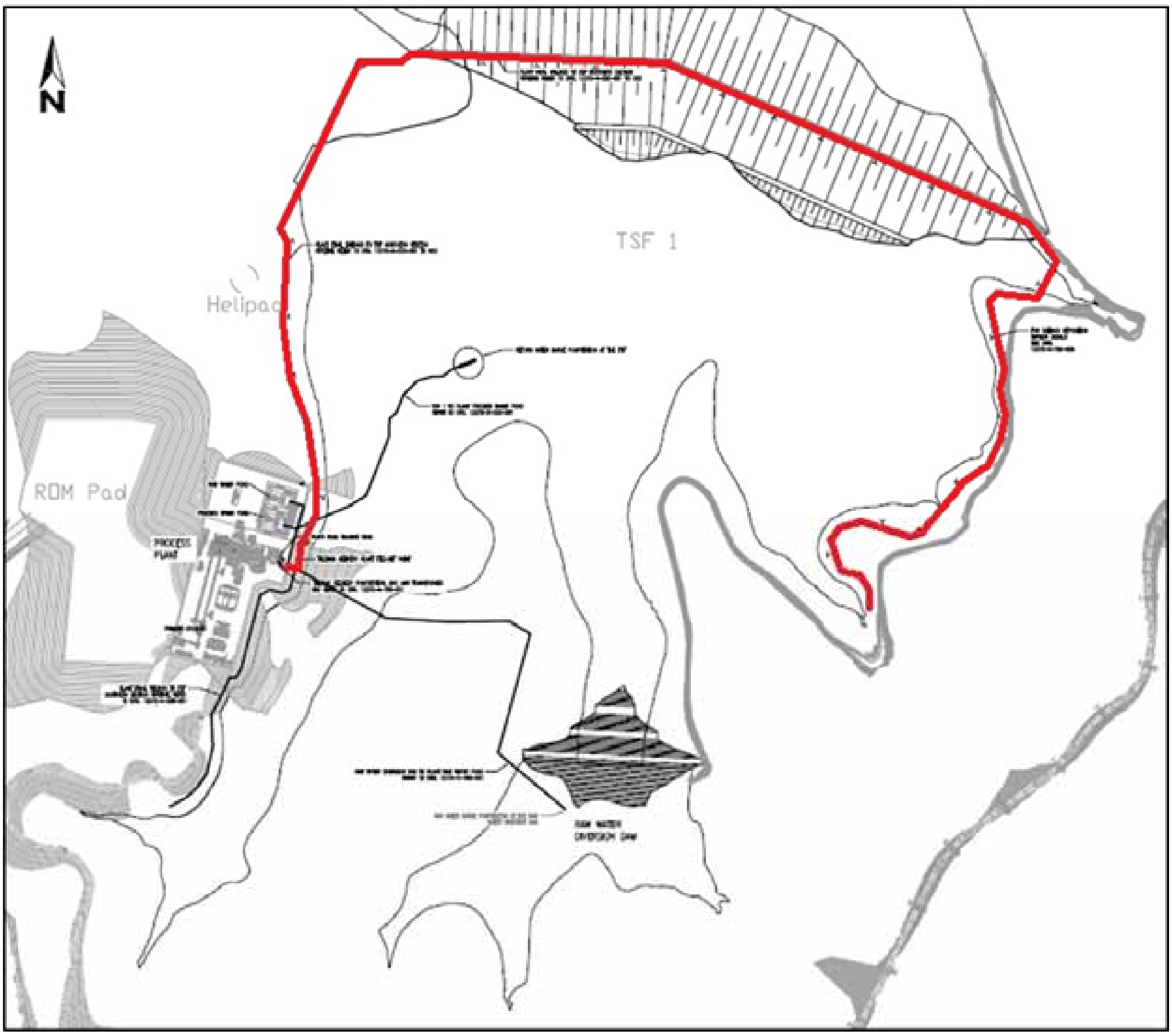

Figure 7-11: Pipeline from the Process Plant Tailings Tank to the TSF Northern Section

7.2.3.4 Process Plant Tailings Tank to TSF (Southern Section Pipeline)

7.2.3.4.1 Pipeline Route

The proposed route for the Southern Section pumping main runs from the Tulu Kapi process plant final tailings tank to the Tulu Kapi TSF Southern Section. The layout of the proposed pipeline route is shown in Figure 7-12. From the longitudinal ground profile, the following can be observed:

- The entire pipeline route length is 465 m
- The invert level of the pipeline at the pump station is 1 664.1 m
- The pipe invert at the discharge point is 1 660 m
- The maximum static head difference between start and end point is -5.062 m
- The highest NGL point along the pipeline route is 1 664.1 m at chainage 0 m

- The lowest NGL point along the pipeline route is 1 660 m at chainage 465 m

7.2.3.4.2 Basic Design Criteria for the Pipeline

The tailings characterisation was finalised as concentration by weight was maximised to no higher than 40 % Cw for the purposes of this study. Tailings design throughput parameters are shown in Table 7-13.

Table 7-13: Tailings Design Throughput Parameters

Parameter	Value	Source/Notes
Solids SG	2.8	Note 6
Dry Tonnage Throughput	250 tph	Note 7
Flow rate	465 m3/h	Note 8

Note 6: Input received from SENET (AMMTEC-NYO-A12931-PrelimVariability-FULL REPORT)
Note 7: Tailings throughput 2,000,000 tpa, with 92% availability.

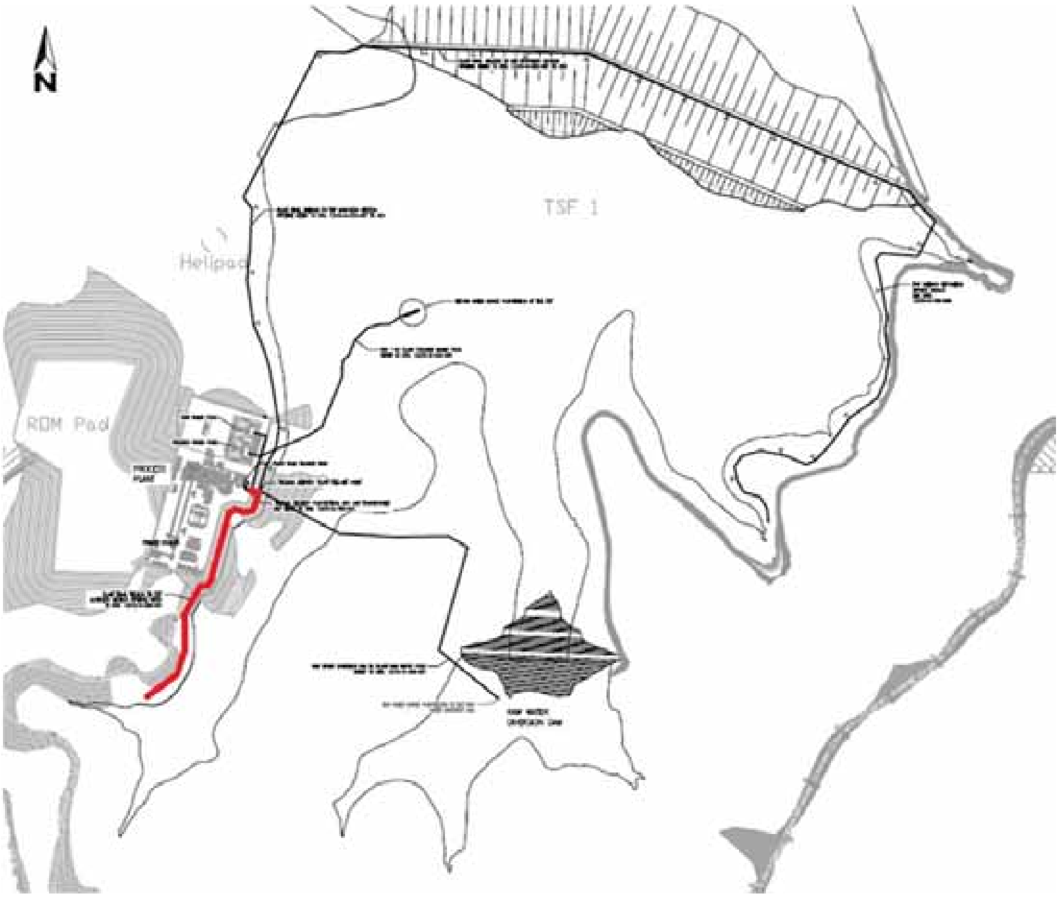

Figure 7-12: Pipeline Route from the Process Plant Tailings Tank to the TSF Southern Section

7.2.4 Tailings Distribution and Deposition Systems

This section summarises the design of the distribution systems to deliver tailings to the TSF.

7.2.4.1 Battery Limits

The tailings distribution system is assumed to start at the end of the tailings transport pipeline as indicated in the drawings. This is actually a seamless connection to the upstream pipeline; however, the design objective of the distribution header is delivery of the tailings within the impoundment. The header will be of the same materials of construction and size as the transfer pipeline and will have multiple tee-off spigots at intervals of approximately 200 m.

The tailings distribution system ends at the outlet of the spray bar spigots, where it deposits the tailings into the TSF. It is assumed that adjustment of the spigot valves will be done manually therefore no power supply is required at the deposition points; however, a small amount of power will be required for the flow meter and isolation valve at the valve station at the start of the distribution system. It is assumed a small power line will have to be brought to this point.

The tailings distribution system will be installed on the crest of the tailings dam wall and final tailings footprint. Any supports or anchors for the pipe will be included.

7.2.4.2 Design Criteria

The general design criteria for the tailings distribution system are identical to the tailings transport system. The spigot spacing for discharge on the dam is as given in Table 7-14.

Table 7-14: Parameters of Tailings Distribution System Design

Parameter	Final Spigot Size	Deposition Station Spacing	Source/Notes
Multiple Deposition	250 ND PE100 PN12.5	100 m	Note 6
Note 1: Input received from SENET (AMMTEC-NYO-A12931-PrelimVariability-FULL REPORT)			

7.2.4.3 Pipeline Route

The distribution header will lie along the Northern TSF dam wall crest and Northern final TSF footprint (Northern Deposition) and Southern Final TSF footprint (Southern Deposition).

7.2.4.4 Hydraulic Design

The hydraulic design has been included in the transport design as discussed above. The hydraulic profile and gradient for the tailings distribution system is included in that for the tailings transport pipeline.

7.2.4.5 Operating Range

The operating range for the tailings distribution system is identical to that for the tailings transport pipeline.

7.2.4.6 Operating Philosophy

The exact location of where the tailings will be discharged on the tailings storage facility will be moved during operation. Firstly, the tailings pipeline splits into two branches at the TSF to transport the sludge to a specific side of the TSF. The flow can be diverted to any of the two branches by opening and closing the appropriate valves at the split. These two valves should never be closed at the same time. When switching from one branch the other, the closed valve should first be opened. Once this line is open and the tailings flow through this line, the other valve can be closed.

The exact point where the tailings are discharged on the TSF at the end of each branch can be moved. Along the branch, there are numerous equally spaced tap-off lines with an isolation valve on each tap-off line. There is also an isolation valve in the main line after the tap-off point. By opening or closing the appropriate isolation valves on the tap-off lines, the exact discharge location can be changed. The valve in the main line just after the active tap-off point should always be closed. If this valve is not closed, the rest of the line will be filled with stationary fluid. Settling will occur in this stationary leg, which could cause blockages.

The active tap-off line will be connected to a mobile deposition piping system. This mobile deposition piping system is shown in Figure 7-13 and consists of two spray bars. Each spray bar has multiple deposition points (about five) to deposit the tailings onto the tailings storage facility. The flow can be diverted to either of the two spray bars by opening and closing the appropriate valves after the T-piece splitting the flow between the two bars.

At least one leg of the mobile deposition piping system (thus one spray bar) should always be open at a time to allow for enough discharge capacity. The operational sequence for the discharge location will be as follows:

- At the start and as needed during operation, the valve of the first tap-off will be opened and the valve in the main line after the first tap-off will be closed. The tap-off is equipped with a mobile deposition piping system consisting of two spray bars. Tailings will be deposited through one of the spray bars by opening the isolation valve to that spray bar. When deposition is complete for the given spray bar, the isolation valve to the other spray bar will be opened, whilst the isolation valve to the first spray bar is closed.

- Once deposition is complete for both spray bars, deposition can be moved to the next tap-off on the main line. Whilst tailings are now deposited through the next tap-off point, the mobile deposition piping system at the first tap-off can be moved to the third tap-off point.
- At least two mobile deposition piping systems will be required for continuous operation. A third mobile deposition piping system should also be available as backup.

This process will be repeated all the way along the branch of the discharge line to the most distant point. When the last tap-off point of the discharge line is reached, the first valve will be reopened and the sequence repeated. Alternatively, the flow can be switched to the other branch and the same sequence will be used on the second branch. Care should be taken to ensure that there is always at least one tap-off line open on a branch before switching to that branch.

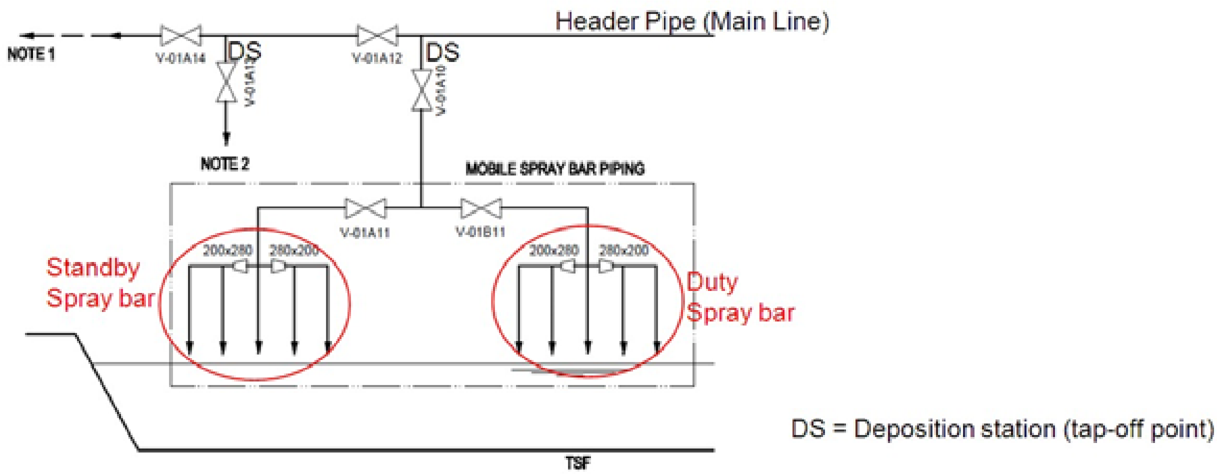

Figure 7-13: Mobile Deposition Piping System with Spray Bar

7.2.5 Reclaim Water Conveyance Systems

7.2.5.1 Battery Limits

Water accumulating in the return water pool in the TSF has to be transferred back to the process water/plant water tank (Item 36 on the Process Plant Block Plan Layout). In designing the water reclaim system (return water system), it was assumed that the Golder Scope of Work includes the following:

- A barge on the return water pool
- Pumps on the barge
- A walkway on pontoons from the return water pool to the beach
- Pipework on the walkway from the pumps to the beach

- Pipework along the valley to the process plant terrace
- Pipework on the terrace to the process water/plant water tank
- A connection to the process water/plant water tank

The following assumptions were made:

- Construction of the process water/plant water tank is not part of the Golder Scope of Work
- The process water/plant water tank will have a flanged inlet pipe at the top of the tank to which the Golder pipework will be connected
- SENET will provide a 400 V electrical power supply connection on the barge
- SENET will provide all the necessary switchgear for the pumps
- SENET will provide all the necessary control equipment for the pumps
- SENET will allow for the connection of the thermal overload sensors and seal leak sensors
- SENET will provide VSDs to synchronise the flow discharged into the process water/plant water tank with the flow abstracted from the process water/plant water tank

7.2.5.2 Operating Philosophies

Floating on the return water pool, the barge will suspend submersible pumps hanging in the water. Despite the rise and fall of the return water pool water level, the pumps will always be submerged. Under normal conditions, water will be transferred from the return water pool to the process water/plant water tank at a rate of 243 m^3/h. Water from the TSF seepage pond can also be transferred to the process water/plant water tank. Top-up water from the RWDD can also be transferred to the process water/plant water tank.

With a storage capacity of 1 000 m^3 in the process water/plant water tank, the flow rate from the return water pool has to be synchronised with the abstraction rate from the process water/plant water tank to prevent excessive stopping and starting of the pumps. This will be done with the VSDs controlling the return water pumps. Controlling of the pumps will be by the SCADA system housed in the Control Building. Each pump will be equipped with the following:

- A gate valve
- A reflux valve
- A pressure meter

As the level of the TSF rises, the return water pool and with it the barge and walkway will move up the valley. From time to time, it will become necessary to move the barge by removing a section of the pipeline.

As the barge moves up the valley, the electrical power supply point will have to be moved. It will therefore also be necessary to shorten the power supply cables and the control cables.

7.2.5.3 TSF Return Water Barge to Plant Process Pond

7.2.5.3.1 Pipeline Route

The proposed route for the rising main runs from the TSF return water barge up the valley to the process water tank. The layout of the conceptual pipeline route is shown in Figure 7-14. From the longitudinal ground profile, the following can be observed:

- The entire pipeline route length is 454 m
- The highest water level at the TSF is 1 658 m
- The lowest water level at the TSF is 1 609 m
- The pipe invert at the discharge point is 1 675.900 m
- The maximum static head difference between the start and end points is 66.9 m
- The highest NGL point along the pipeline route is 1 675.900 m at the process plant
- The lowest NGL point along the pipeline route is 1 608 m at the inlet

7.2.5.3.2 Basic Design Criteria

From the basis of the design, the following flows are given for the pipeline from the TSF return water barge to the plant process water tank:

- Daily average flow: 5 832 m^3/d
- Instantaneous average flow: 67.5 m^3/s (24 pump hours per day)
- Instantaneous peak flow: 67.5 m^3/s (24 pump hours per day)

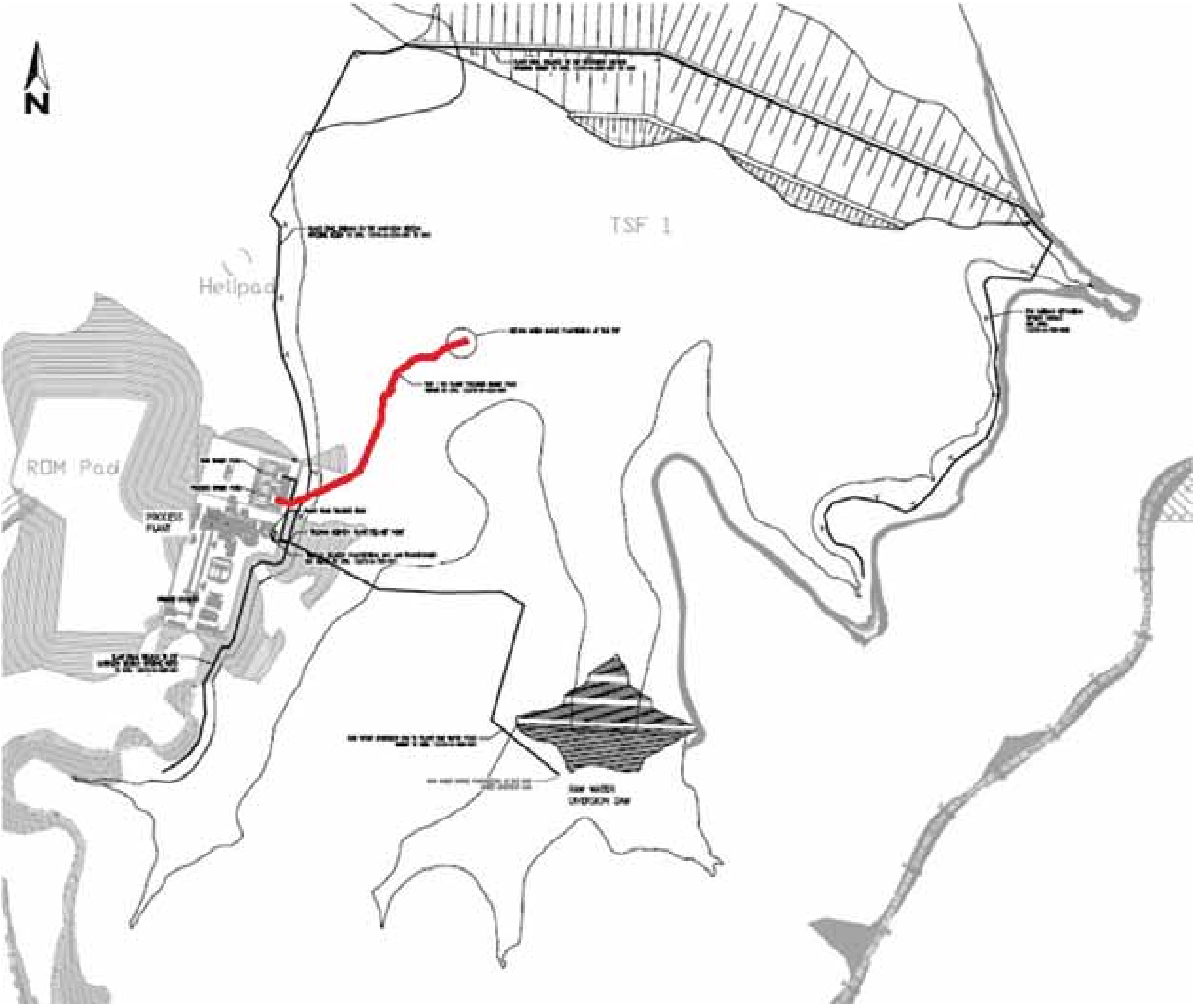

Figure 7-14: Pipeline Route from TSF Return Water Barge to the Plant Process Water Pond

7.2.5.4 RWDD Barge to Plant Raw Water Tank

7.2.5.4.1 Pipeline Route

The proposed route for pumping raw water runs from the RWDD to the proposed raw water pond (RWP). The layout of the conceptual pipeline route is shown in Figure 7-15.

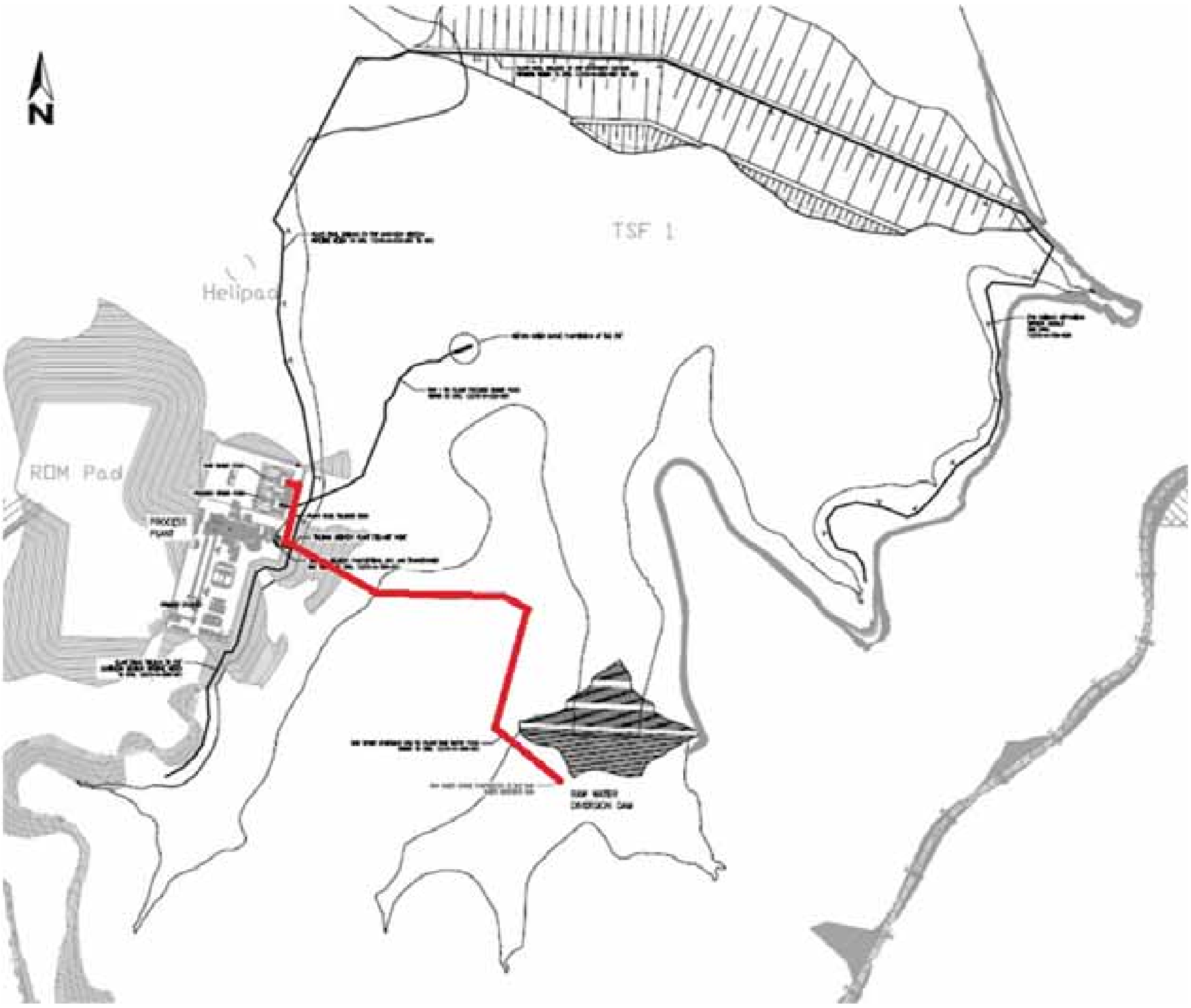

Figure 7-15: Pipeline route from the RWDD to the Plant Raw Water Pond

From the longitudinal ground profile, the following can be observed:

- The entire pipeline route length is 1 200 m
- The invert level of the pipeline at the bottom of the RWDD is 1 647.0 m
- The top water level of the RWDD is 1 668.5 m
- The pipe invert at the discharge point is 1 673.0 m
- The maximum static head difference between the start and end points is 26.0 m
- The highest NGL point along the pipeline route is 1 673.0 m at the discharge
- The lowest NGL point along the pipeline route is 1 647.0 m at the inlet

7.2.5.4.2 Basic Design Criteria

From the basis of the design, the following flows are given from the RWDD to the plant raw water tank:

- Daily average flow: 6 456 m^3/d
- Instantaneous average flow: 74.7 L/s = 269 m^3/h (24 pump hours per day)
- Instantaneous peak flow: 74.7 L/s = 269 m^3/h (24 pump hours per day)

7.2.6 Cost Summary

7.2.6.1 Indicative Cost Summary for Pipeline Systems

The indicative capital expenditure costs (CAPEX), O&M costs, and replacement costs are shown in Table 7-15. For the purposes of this report, the indicative life cycle costs were calculated using 5 % interest and 2.5 % escalation over a 10-year analysis period.

The following replacement assumptions were used to assess the replacement cost where applicable for the assumed life cycle of 10 years:

- For the reclaim pipeline systems:
  - A 30-year replacement period for the pipelines, structures, and buildings
  - A replacement of 25 % of the mechanical and electrical infrastructure for the pump stations every 15 years
- For the tailings pipeline system:
  - A 20-year replacement period for the pipelines, structures, and buildings
  - A replacement of 100 % of the mechanical infrastructure for the pump stations every 5 years
  - A replacement of 25 % of the electrical infrastructure for the pump stations every 15 years

The following maintenance cost assumptions were used to calculate the annual maintenance costs for all systems:

- Mechanical and electrical infrastructure annual maintenance costs were calculated as 8 % of the CAPEX of the mechanical and electrical infrastructure
- The annual civil infrastructure maintenance cost was calculated as 1 % of the CAPEX of the civil infrastructure

Table 7-15: Indicative Capital Expenditure, Annual O&M, and Replacement Costs

Stream No.	Pipeline system	Capital Expenditure Cost* (US$)	Annual O&M Cost* (US$)	Present Value Replacement Cost (US$)
1A	Process Plant Final Tailings Tank to TSF Northern Section	573 351	54 699	88 228
1B	Process Plant Final Tailings Tank to TSF Southern Section (Excludes Pump Station Costs included above)	48 207	9 661	0
2	TSF Return Water Barge to Plant Process Water Pond	164 586	30 366	0
3	RWDD Barge to Plant Raw Water Pond	108 609	20 199	0

* Costs which were estimated from Supplier quotations and are not tender enquiry pricing from a Contractor.
* The above listed Capital Expenditure Cost excludes P&G's, Contingencies, EPCM, Regulatory permitting and Servitudes.
* Prices are Based on Discounted Prices (Not Listed Prices).
* Prices are based on local South African Prices and an Exchange rate of R8 per US $.
* Replacement costs are at year 5.
* All the pipelines and valves are included in the above.
* Prices exclude import taxes.

The detailed design for the tailings/reclaim water infrastructure is presented in Annexure 7-2 (Tailings and Reclaim Water Conveyance Infrastructure (Civil / Structural / Mechanical Design Report).

7.3 GEOTECHNICAL INVESTIGATION FOR PROJECT INFRASTRUCTURE

A geotechnical investigation was performed to support the design, and future construction, of the Tulu Kapi Gold project TSF, process plant, primary crusher, and raw water dam. Note that the previously proposed raw water dam (RWD) was relocated into the TSF drainage area and is now referred to as the raw water diversion dam (RWDD). The geotechnical programme was planned to determine the subsurface conditions for the process plant, the previously proposed RWD area, and TSF foundations as well as the suitability of the soils for use as structural fill or low-permeability soil liner material. The investigation included the following components:

- A subsurface geotechnical exploration of the facilities' foundation geology was conducted in January and February 2012. The subsurface exploration included excavating 69 test pits and completing 10 exploratory borings.

- Geotechnical laboratory testing was performed on soil samples retrieved from the subsurface field investigation for soil classification and to determine the site soil geotechnical properties to support the design of the project infrastructure.
- Geotechnical analyses were performed in support of the facility designs. Analyses included seepage analyses of the TSF and the previously proposed RWD (and subsequent RWDD) structures. Slope stability analyses were also performed for the TSF, the previously proposed RWD (and subsequent RWDD), and the process plant building pad using the recommended and proposed facility geometries and soil material properties based on laboratory testing of subsurface samples for each facility. The process plant infrastructure components were also analysed for foundation-bearing capacity as well as for both total and differential settlement.
- Geotechnical engineering design and construction recommendations were developed for the infrastructure earthworks.

A geotechnical design report that summarises and documents the field investigation, laboratory testing, analyses, and recommendations was prepared. This section summarises the key components of the complete geotechnical report, titled "Tulu Kapi Gold Project Mine Infrastructure Geotechnical Report" that is included in Annexure 7-3.

7.3.1 Subsurface Investigation

The DFS infrastructure geotechnical field investigation was conducted from 9 January to 10 February 2012. The geotechnical investigation included both test pits and geotechnical soil borings to define the near-surface geotechnical and groundwater models and provide subsurface data for subsequent analyses. The exploration programme included drilling 10 borings/rock cores to depths of between 12 m and 30 m below the ground surface for a total depth of drilling of 274.5 m. Of this total, 185 m were in soils and 89.5 m were in weathered to competent rock that required rock coring techniques. The programme also included excavating 69 test pits to depths of up to 5 m below ground surface. Table 7-16 presents a summary of the field exploration programme conducted for each of the three facilities. Figure 7-16, Figure 7-17 and Figure 7-18 show the test locations.

Table 7-16: Geotechnical Boring and Test Pit Programme Summary Table

Infrastructure Facility	Number of Test Pits	Number of Boreholes	Total Borehole Soil (m)	Total Borehole Rock (m)
Process Plant/Primary Crusher	11	4	112.2	7.8
Tailing Storage Facility (TSF)	30	3	30.4	41.6
Previously proposed Raw Water Dam (superseded by the RWDD)	28	3	42.4	40.1
Total	**69**	**10**	**185.0**	**89.5**

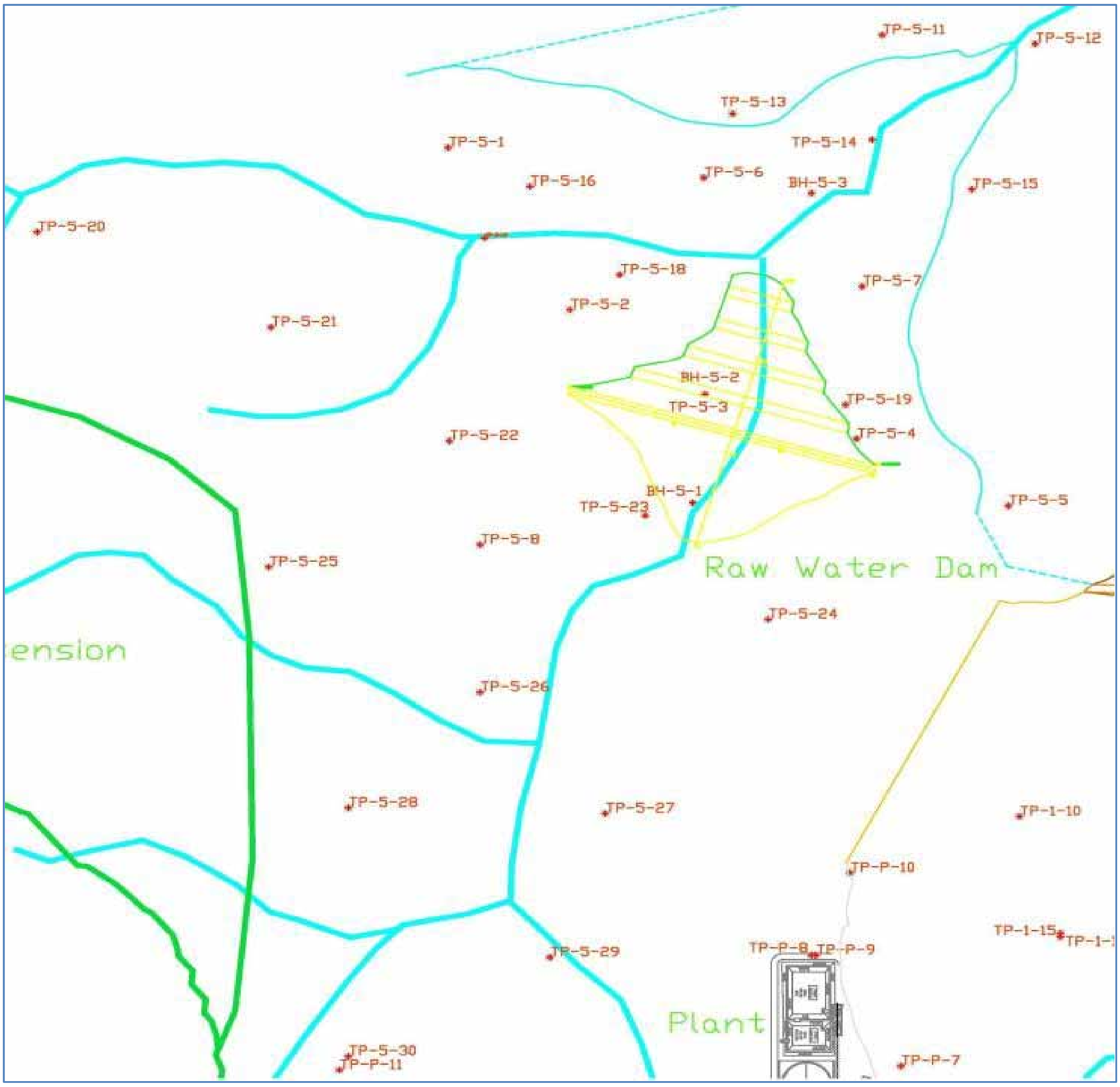

Figure 7-16: Previously proposed RWD Area, Geotechnical Boreholes, and Test Pit Locations

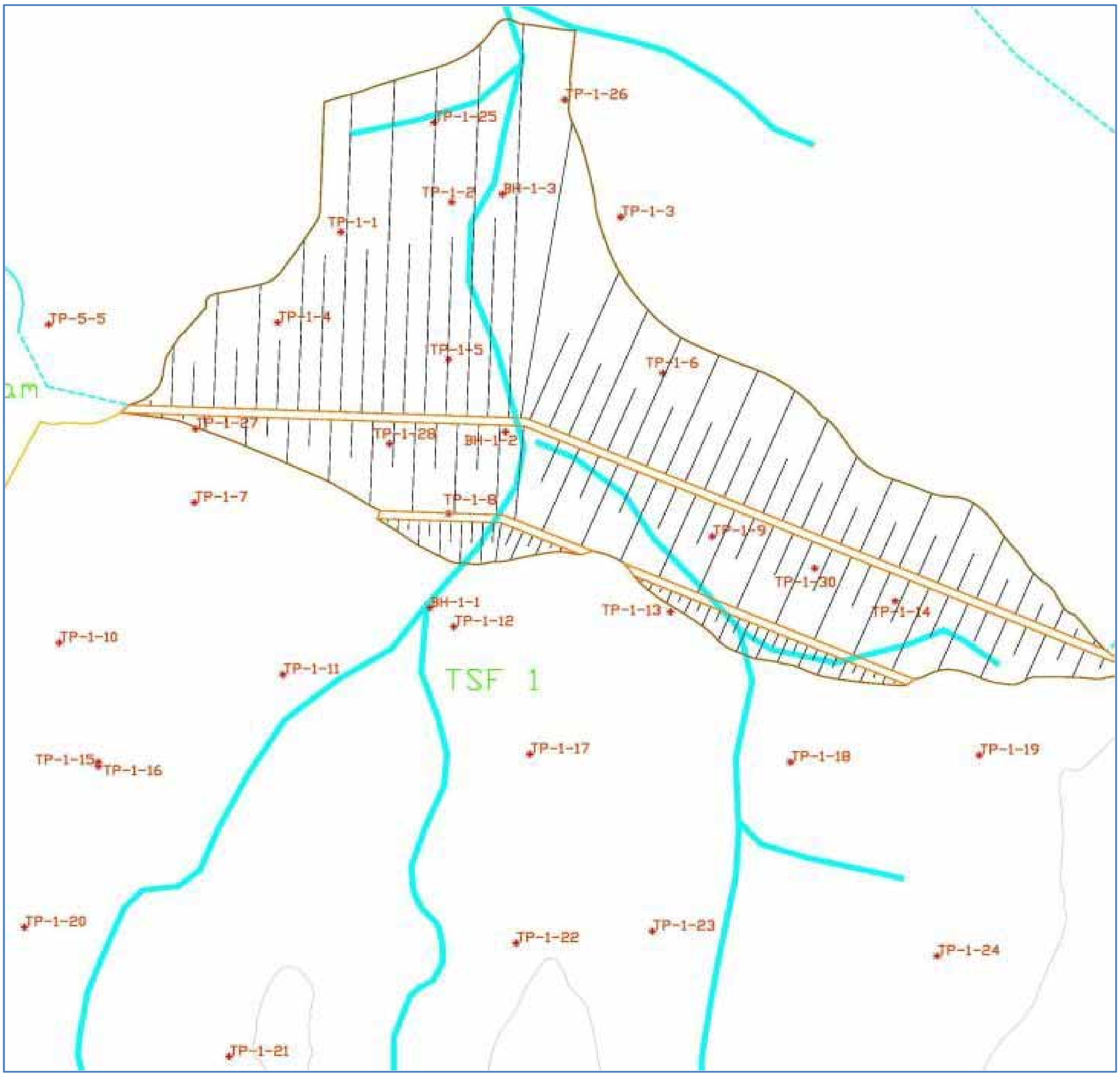

Figure 7-17: TSF Area – Geotechnical Boreholes and Test Pit Locations

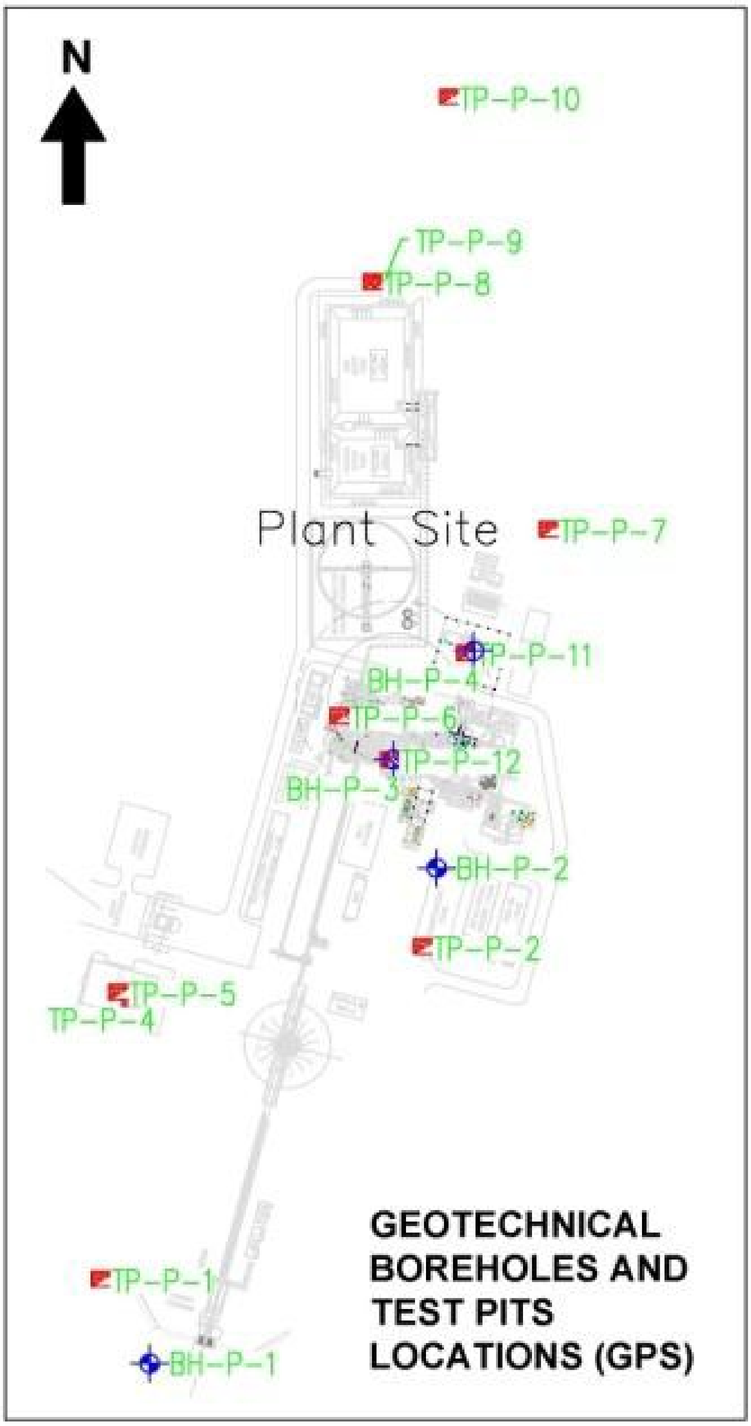

Figure 7-18: Plant Area – Geotechnical Boreholes and Test Pit Locations

In addition to logging the borings and test pits, standpipes piezometers were installed in late March and April 2012 to monitor water levels though the coming wet season. These screened standpipe piezometers will be used to monitor groundwater levels prior to and during upcoming construction activities and future facility operations. Additional detail regarding the depths to bedrock and groundwater encountered in the field investigation for each facility are included in the complete geotechnical report in Annexure 7-3.

7.3.2 Geotechnical Laboratory Tests

Laboratory tests were conducted on select materials from the explorations performed at each of the three facilities. Laboratory tests were conducted by the Water Works Design and Supervision Enterprise (WWSE) in Addis Ababa and Golder's Atlanta, Georgia USA laboratory.

Tests that were performed included laboratory moisture content, Atterberg limits, particle size distribution, remoulded, and undisturbed consolidated-undrained (CU) triaxial strength, saturated hydraulic conductivity, consolidation, and dispersion testing. The geotechnical laboratory tests performed as part of the infrastructure geotechnical investigation are summarised in Table 7-17. The complete laboratory test results are presented in Annexure 7-3.

Table 7-17: Summary of Laboratory Testing Programme

Test	Plant/Primary Crusher	TSF	(aka TSF 5)	Total
Gradation/Atterberg/Moisture	36	31	27	94
Oedometer	4	2	2	8
Triaxial	6	4	2	12
Permeability	0	6	5	11
Dispersiveness	4	6	5	15
Modified Proctor	3	4	7	14

7.3.3 Geotechnical Laboratory Tests

This section summarises the descriptions and discussions of the strength properties, permeability, and unit weights selected for the soil and rock materials that will be used as foundation material or engineered fill for the proposed facilities. Foundation materials that will support the facilities include alluvium, saprolite, laterite, and bedrock. Fill materials will consist of laterite, filter materials, and waste rock. The properties of these materials are discussed in the sections below.

7.3.3.1 Laterite and Saprolite

The laterite and saprolite at the site and in the region are deeply weathered, oxidised bedrock consisting mainly of low to high plasticity silts, with some clays, silty clays, and silty sands. The laterite, where encountered at the site, overlies the saprolite to depths of between 0.3 m and 5 m below the ground surface. Based on laboratory classification, the laterite and saprolite were found to be very similar in grain size and plasticity, with the laterites generally slightly more coarsely grained and more uniform.

7.3.3.2 Embankment and Engineered Fill

Soil embankments constructed of laterite, silty clays, and clayey silts should be designed with the shear strength parameters summarised in Table 7-18. The shell of the process pond embankments may be constructed using general borrow of the silty clay and clayey silt. The pond embankment core should be constructed of select borrow that grades as low to medium plasticity clay (CL) with a liquid limit (LL) greater than 30 % and a plastic limit (PL) greater than 13 %.

Unlined process pond embankments should be designed with a suitable toe-drain/sub-drain system to reduce piezometric pressures within the embankment. A clay core and interconnected key trench are recommended to mitigate seepage through and under the process pond embankment.

Table 7-18: Soil Material Engineering Properties

Unit	Weight (kN/m^3)	Cohesion (kN/m^2)	Phi (Φ) (degrees)	Permeability(sat) (cm/s)
Clay core and key trench	18.76	4.7	34	1×10^{-6} cm/s
Subgrade soils (in situ)	18.7	4.7	34	5×10^{-6} cm/s
Up/downstream shells	18.7	4.7	34	2×10^{-6} cm/s
Filter material	17	0	32	1×10^{-4} cm/s
Toe drains	22	0	32	1×10^{-3} cm/s

7.3.3.3 Waste Rock Fill

The waste rock fill strength was estimated utilising typical strength parameters for waste rock of 38 degrees internal friction angle (Ø), no cohesion, and a unit weight of 20 kN/m^3. These values are based on similar projects, however, as the Tulu Kapi waste rock is developed during mine construction, these typical values will be reviewed to confirm or modify them as necessary. For seepage modelling, a hydraulic conductivity of 1×10^1 cm/s was assigned to truck-dumped coarse and angular mine waste rock.

7.3.3.4 Filter and Toe-Drain Fill

A granular filter was incorporated in the design of the raw water dam. The filter fill consists of washed sand to remove fines. Such a cohesionless, granular material is typically characterised with a strength using parameters of an internal friction angle (Ø) of 32°, no cohesion, a hydraulic conductivity of 1.0 × 10^{-4} cm/s, and a unit weight of 17 kN/m^3.

The toe drain for the raw water dam can be produced by crushing rock from the on-site quarry. A typical gradation for the toe drain would be a 40 mm minus crushed rock that is screened to remove fines. This material was modelled as having a unit weight of 22 kN/m^3, an internal friction angle (Ø) of 32°, no cohesion, a hydraulic conductivity of 1.0 × 10^{-3} cm/s.

7.3.3.5 Slopes

Permanent fill slopes should be 3H:1V or flatter and permanent cut slopes should be 2H:1V or flatter. Cut slopes into fused laterite rock, if encountered, may be made at 0.5H:1V. Surface drainage should be directed away from all slope faces, or alternately, provision should be made to mitigate erosion. All soil cut and fill slopes should be seeded as soon as possible to encourage the development of vegetative cover or be otherwise protected.

7.3.4 Process Plant/Primary Crusher

The site soils at the process plant/primary crusher area generally consist of little to no topsoil (from 0 to 300 mm) underlain by stiff to very stiff silty clay and clayey silt lateritic soils varying in depths from 1 m to 1.7 m below ground surface. These soils are underlain by thicker strata of very stiff to hard silty clay and clayey silt saprolite that extend to approximately 15 m to 22 m below the ground surface where the soil becomes a mixture of highly weathered rock and soil referred to as “sap-rock”. In BH-P-01 the sap-rock depth extended to 24 m where it transitioned into weathered rock, becoming less weathered with depth. In boreholes BH-P-02, BH-P-03, and BH-P-04 the sap-rock extended to the full 30 m depth of the boreholes. Specific foundation recommendations for allowable bearing capacity and settlement for the process plant/primary crusher are described in the complete geotechnical report included in Annexure 7-3.

7.3.5 Tailings Storage Facility

The Tailings Storage Facility (TSF) will be formed by constructing a dam across a shallow natural drainage. The TSF will be initially constructed with starter walls and raised sequentially to enable the storage of tailings to an elevation of 1 658 . The TSF will be developed in four raises using downstream construction methods with the bulk of the embankment fill consisting of mine waste rock. At the end of the final stage, the TSF will have the capacity to store 11.6 million m^3 (~15.4 Mt) of tailings.

The site soils within the TSF generally consist of topsoils that range in depth from 0.3 m to 0.8 m underlain by a laterite clayey silt layer ranging from 1 m to 5 m. The laterite layer is underlain by saprolite that becomes sap-rock and eventually rock with depth. Three borings were advanced under the TSF dam footprint. The depth to rock in borings BH-1-01, BH-1-02, and BH-1-03 was 15 m, 10.5 m, and 6.4 m, respectively. The rock became stronger with depth, i.e. due to decreased weathering.

7.4 RAW WATER DIVERSION DAM AND SPILLWAY CHANNEL

The previously proposed raw water dam was initially sited in the formerly TSF 5 area to supply raw water for the process plant during the operation. Since the geotechnical investigation, the dam, now referred to as the Raw Water Diversion Dam (RWDD), is located in the southern extent of the TSF drainage area.

The water supply for the RWDD will be from surface water run-off. The proposed raw water dam is located and is situated within a valley bounded by the moderately steep slopes of the surrounding terrain in one of the drainages located south of the TSF. Key elements of the reservoir include an earth fill dam and a spillway.

The dam will consist of a zoned earth fill dam composed of an upstream embankment of compacted laterite and mine waste rock downstream, separated by a filter/drain chimney drainage blanket. The upstream embankment will be founded on in-situ soil; while the centre compacted laterite embankment will be constructed with a cut-off trench that will be excavated up to 3 m into the founding soils. The maximum height of the embankment from natural ground level at the downstream toe (~1 640 m) to the crest at elevation (1 669 m) is ~29 m. The total length of the dam at the crest is ~268 m.

Figure 7-19 shows the Tulu Kapi RWDD and spillway diversion channel.

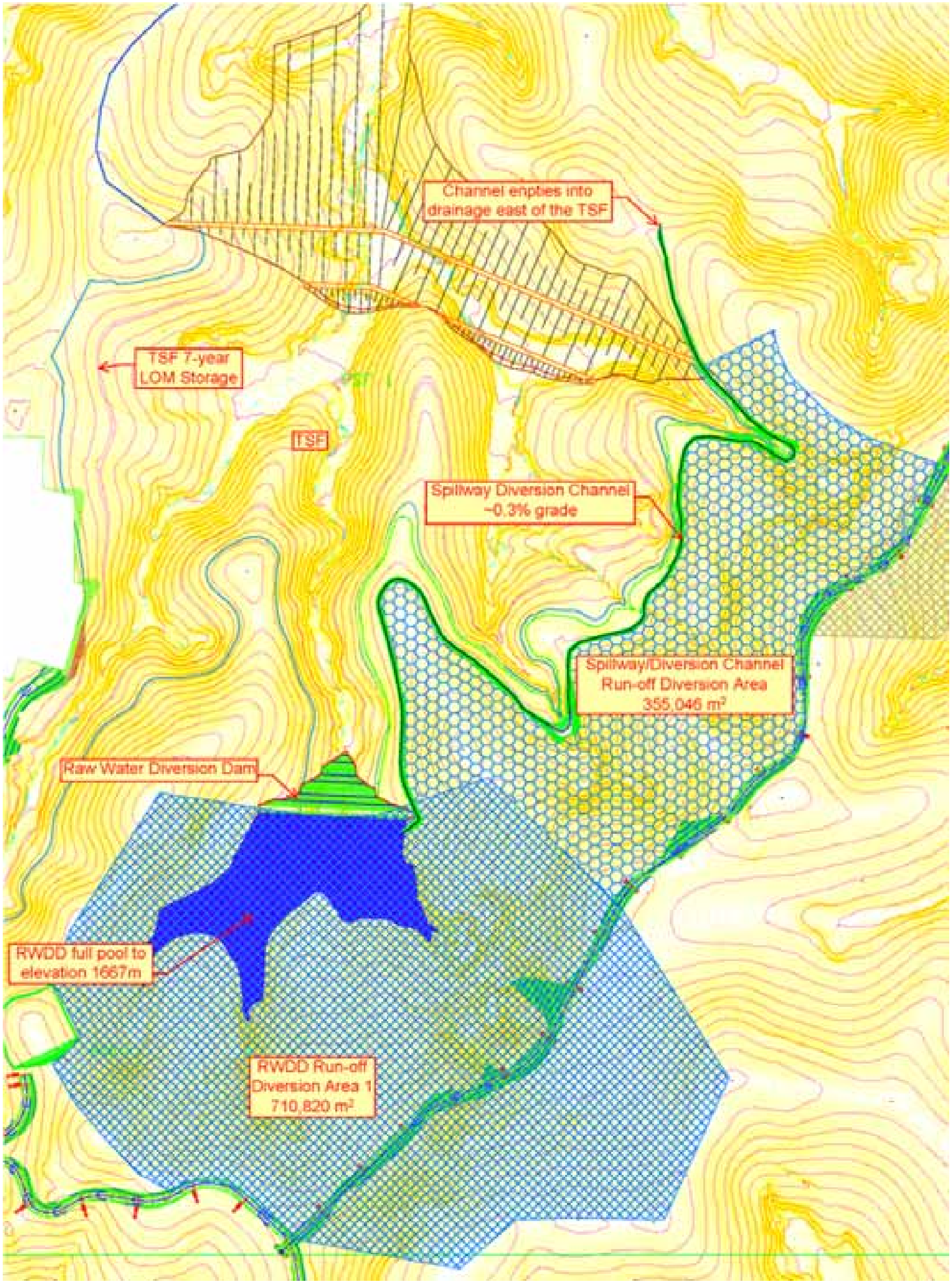

Figure 7-19: Tulu Kapi RWDD and Spillway Diversion Channel

The spillway invert elevation is 1 667 m. At this elevation, the RWDD has a storage capacity of ~550 000 m^3. A spillway channel is located at the east abutment of the RWDD with the spillway invert set at 2 m below the dam crest. The spillway will be extended downstream on an approximate 0.3 % grade and serves not only to manage water spilling from the RWDD, but also intercepts the natural drainage that would otherwise enter the TSF. The spillway diversion channel diverts water around the TSF and into a topographic drainage east of the TSF.

Based on test pit information in the RWDD area in the geotechnical investigation, the soils generally consist of little to no topsoil (from 0 to 300 mm) underlain by stiff to very stiff silty clay and clayey silt lateritic soils varying in depths from 1 m to 1.7 m below ground surfaces. These soils are underlain by a thicker stratum of very stiff to hard silty clay and clayey silt saprolite that extends to approximately 2.7 m to 24 m below the ground surface where the soil becomes a mixture of highly weathered rock and soil referred to as sap-rock. Test pits were used in the geotechnical investigation but no boreholes were advanced in the current location of the RWDD. The RWDD design report is presented in Annexure 7-4.

7.4.1 RWDD Embankment and Foundation

The zoned earth-fill dam will include an upstream compacted laterite 3H:1V (Horizontal:Vertical) slope embankment (Zone 1), chimney and blanket filter/drains (Zone 2), and a downstream 2H:1V slope compacted mine waste rock buttress (Zone 3). To provide erosion protection, rip-rap will be provided on the upstream face, while the downstream face is mine waste rock. A typical section with the associated details of the zoned earth-fill dam is presented in Figure 7-20 below.

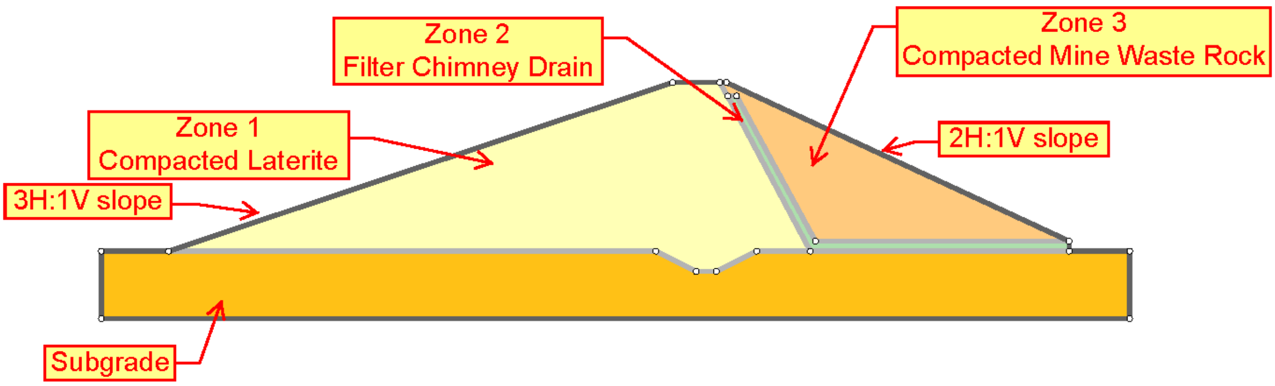

Figure 7-20: Tulu Kapi RWDD Typical Section and Construction

Surface preparation will be limited to the removal of a thin layer, in the order of 150 mm to 300 mm of topsoil. The underlying subgrade will be compacted prior to placement of the dam zone materials.

The compacted laterite embankment will be constructed of the relatively low permeability silts and clays from the borrow areas established during pit development. The top of the compacted laterite embankment starts at an elevation of 1 669 m, 2 m over the reservoir maximum operating level and at the same level as the crest. The laterite zone is 8 m wide at the top.

Beneath the main compacted laterite embankment will be a cut-off trench, which will be excavated through the subgrade soils extending approximately 3 m in depth. The slopes of the cut-off trench will be approximately 2H:1V. Generally, the cut-off trench depth will depend on the materials exposed during cut-off excavation; its depth in bedrock may be less than 3 m or deeper. If competent, relatively impervious rock that would require blasting to excavate 3 m into it is exposed, it may be prudent to stop the excavation short of the specified depth to avoid fracturing the rock with blasting operations. Conversely, if the rock is highly fractured and pervious, it may be prudent to excavate deeper than the specified depth and dental concrete and slush grout will be used to prepare the exposed bedrock surface throughout the entire cut-off trench.

The downstream buttress will be constructed of compacted mine waste rock from the pit development excavations. Generally, the main objective of the mine waste rock buttress is to provide stability to the embankment. The downstream surface will not be subject to erosion as it is rock, but the mine can elect to place tailings against the downstream surface.

Between the compacted laterite embankment and the downstream mine waste rock, a filter/drain chimney that also extends beneath the downstream buttress is included. The purpose of the chimney and blanket drains is to control the phreatic surface to improve stability of the structure, and provide a pathway for collected flows to safely and securely pass through the embankment. The chimney filter/drain will have a performance specification for hydraulic conductivity and, in the final design, it will include a specified gradation filter to limit fines migrating from the compacted laterite embankment into the mine waste rock and prevent piping.

Due to the dual considerations of the chimney, it is referred to as the filter/drain chimney and will be comprised primarily of well-graded sand. A blanket filter drain will be placed beneath the downstream shell above the foundation. The objective of the blanket drain is twofold: it will collect and pass flows from the chimney drain, as well as seepage flows from the foundation. The filter blanket will be comprised primarily of relatively well-graded sand, similar to that used in the chimney. A toe drain will be constructed on the outer edge of the dam to collect all flows to a main pipe exit. No distinct borrow areas have been identified for material to construct the chimney and blanket drains, but they potentially could be produced as a by-product of the on-site rock quarry gravel crushing operation.

The materials in the borrow areas should be suitable for construction of the embankment and buttress. Use of these materials will require care for use in compacted laterite embankment construction since the rule of thumb is to specify a minimum of 25 % silt or clay sizes. A brief summary of the materials and quantities required is provided in Table 7-19.

Table 7-19: Summary of RWDD Borrow Material

Material Type	Location of Use	Quantity (m^3)	Possible Sources
Laterite Silt/Clay Material	Zone 1 - Cut-off Trench	132 232	Borrow areas, spillway channel excavation
Free-Draining Sand	Zone 2	3 878	Crushed and screened material from pit, screened material from local borrow areas
Mine Waste Rock	Zone 3	45 467	Pit excavation areas

Selected instrumentation will be necessary to monitor dam performance; this should be specified during detailed design; however, an overview of the expected instrumentation is provided below.

Piezometers will be installed to measure pore water pressures in the foundation, both upstream and downstream of the cut-off trench, filter/drain, and downstream shell of the dam. The objective of the piezometers is to monitor pore pressure regimes through and under the dam to observe the following:

- Head loss through the dam is occurring in the compacted laterite embankment
- Head loss in the shallow foundation is occurring at the cut-off trench
- The downstream shell of the dam is fully drained (the phreatic surface is in or below the chimney and blanket filter/drain)

Flow monitoring instrumentation should be installed downstream of the dam to measure the amounts of water passing through the dam. Surface movement monitoring points should be installed on the crest and along the downstream toe of the embankment for routine monitoring by survey.

7.4.2 Spillway/Diversion Channel

The 2 180 m long spillway/diversion channel manages both the water from the RWDD spillway and the diversion area upslope from the channel. The channel was designed to pass a PMF 24-hour storm event (463 mm). The minimum 1 m deep spillway channel section was selected as a trapezoidal section spillway excavated almost entirely in cut with side slopes of 1H:1V. The channel bottom width is a minimum of 2 m at the RWDD and varies in width as it progresses eastward. The spillway invert elevation is 1 667 m and the channel empties into the adjacent topographic drainage at the east end of the channel at an elevation of 1 660.5 m. The design peak flow for the spillway is 0.9 m^3/s and the maximum reservoir elevation required to pass this flow is 1 667.4 m. The spillway outlet channel begins at the east side of the RWDD reservoir and extends eastward where the channel intercepts run-off from the drainage area above the channel and diverts both the spill from the RWDD and the intercepted run-off to the topographic drainage basin east of the TSF. The Spillway/Diversion Channel will be optimised in the detailed design phase which may mean a slightly wider channel bottom width for the eastern sections of the channel to minimise flow velocities.

7.5 MINE WASTE DUMPS

The Mine Waste Dumps (MWDs) were designed to contain waste rock from the open-pit operations. There are three preferable locations for the waste dumps: directly west of the pit; north of the pit; and south of the pit as shown Figure 7-21 below.

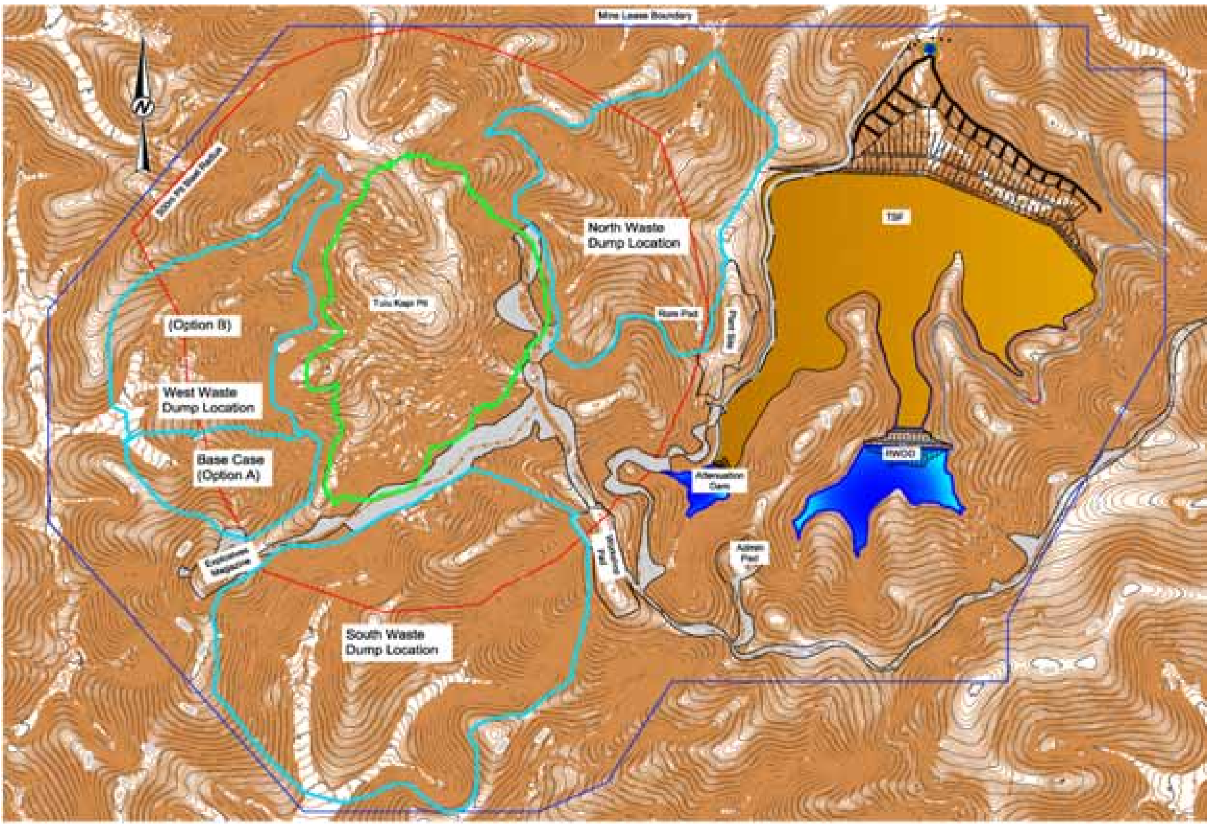

Figure 7-21: Mine Waste Dump Locations

The three mine waste dumps that were designed included the North Waste Dump (NWD), West Waste Dump (WWD) and South Waste Dump (SWD). Combined these three waste dumps provide the required mine waste storage capacity for the current mine plan. The Mine Waste Dump Design Report in Annexure 7-5 details the waste dumps' operational and closure design configurations, surface water management, and stability evaluations of both proposed mine waste dumps.

7.5.1 Design

7.5.1.1 General

The three waste dumps are required to contain a total of 115 803 000 t of waste material from the pit as required by the mine plan. The NWD located to the northeast of the pit has been designed to have a capacity of 15 100 000 m^3, the SWD located directly to the south of the pit has a design capacity of 49 500 000 m^3, and the WWD has a design capacity of 3 900 000 m^3. Using an estimated mine waste density of 2.1 t/m^3, this translates to 31 700 000 t for the NWD, 104 000 000 t for the SWD, and 8 200 000 t for the WWD.

In addition to the WWD base case (Option A), a larger option (Option B) was designed to potentially expand the WWD in the future. Option B has a design capacity of 15 300 000 m^3 which translates to 32 130 000 t. Option B is included in Annexure 7-5 for information, but the DFS relies on the WWD base case (Option A) for the overall mine waste storage and corresponding cost estimates.

The waste dumps have been designed to maximise land use in the valleys as the natural landform of the mine site is characterised by rounded hills and deeply incised valleys. The footprint of each waste dump was limited to a catchment area in order to facilitate surface water management both during operation and at closure.

The waste dumps have been designed to be stable during both operations and closure. As mentioned above, no geotechnical investigation has been carried out at the SWD site and only a limited investigation was performed for the WWD site. Golder's geotechnical investigation carried out in 2012 was limited to the TSF, raw water dam/TSF 5 area (now the NWD area), and process plant site areas. All geotechnical information relating to the saprolite and rock fill placed in the waste dumps in order to perform the slope stability analysis (i.e. c, ϕ, γ), as well as geotechnical information regarding the foundation of the dump footprints was based on the geotechnical data obtained from the ground investigation primarily from the current NWD area, supplemented by information from investigations of the nearby TSF, process plant, and WWD.

7.5.1.2 Underdrain System

As the mine waste dumps will consist primarily of mine waste rock, it is expected that water will seep through the waste dumps following rainfall events. The seepage will be collected through an underdrain system and be discharged into the environment after passing through sedimentation ponds located at the lowest point of each facility's footprint.

The underdrain system has been designed as a selected rock fill blanket drain placed at the bottom of the natural drainage valleys which collects flows down the steep topography and provides a positive drain for the waste dump and will subsequently reduce pore pressure within the waste fill. The blanket drain extends to the lowest point in the MWD footprint area where the flow passes through a settling pond before discharging into the environment. The blanket drain has a trapezoidal shape with a 5 m bottom width and is 1.5 m thick. The drain is constructed with selected rock fill and follows the natural ground drainage slope at the bottom of the valleys. An A6 geotextile completely envelops the blanket drain to minimise the potential for fine particles to clog the drains. The select rock fill grading for the mine waste rock drains is 500 mm to 4.75 mm (< 5 % passing 4.75 mm). The layouts and typical cross section of the underdrain collection system for the north and south mine waste dumps are presented in Annexure 7-5.

7.5.1.3 Profiles and Closure Profile

The profile of the mine waste dumps has been designed to facilitate reshaping of the waste dump benches at closure to a 3H:1V (Horizontal: Vertical) side slope. During operations, the MWD will be constructed in typical 16 m lifts with a natural slope of the saprolite/rock waste of 1.375H:1V. The operational lifts are separated by 31 m wide benches.

During final closure construction, the slopes will be re-graded to develop a closure slope of 3H:1V with approximately 5 m wide benches. These benches will be graded to direct surface water run-off to drainage down chutes during closure. The shaped side slopes will be capped with topsoil and seeded to minimise the potential for erosion. In the event that natural slope angles vary from that designed, then the bench widths will have to be amended during the MWD development. Slope angles can vary due to material properties, i.e. soil or rock waste, compaction, and moisture content.

7.5.1.4 Water Management during Operations and at Closure

Surface water management is a critical operation during the development of an MWD. The north and south MWDs were sited within a single catchment each to minimise storm water run-on to the MWD and to facilitate surface water management in and around the facilities.

During operations, it is expected that, following precipitation, a significant percentage of rainfall will infiltrate and seep through the waste rock, exiting at the lowest toe area of the waste dumps. A settling pond has been designed for each waste dump to collect and slowly release surface/seepage water from the facility to allow medium silt-sized particles (0.006 mm in diameter) to settle before discharging collected surface water into the environment. The pond shall be constructed at the discharge point of the underdrain system as shown in the design drawings in Annexure 7-5. The settling pond was sized based on a design 24-hour rainfall depth of 49 mm for a 1:2 year return period (Peens & Associates, 2012) and a run-off coefficient of 15 % through the waste rock (Golder, 2012). The settling ponds are a minimum of 4.2 m deep, and have a 2H:1V side slope with plan dimensions of 65 m × 40 m and 60 m × 35 m for the NWD and SWD, respectively. A 0.2 m freeboard was allowed in the design. Layouts and a typical section of the settling ponds are provided in Annexure 7-5.

During final closure and rehabilitation, down chutes have been designed as controlled outlet structures to manage surface water on each waste dump. At closure, the benches will be graded such that collected surface water flows towards the nearest respective down chute structure. The down chutes will convey the collected surface run-off to an uncapped section of the rock waste dump where the run-off will seep through the rock mine waste and subsequently flow to the sedimentation ponds via the underdrains. A collection ditch has been designed, where required, to collect and discharge surface water flow from the down chutes and any run-on toward the mine waste dump into the settling pond at closure. The collection ditch will be constructed as a 1.5 m deep trapezoidal open channel, with a bottom width of 2 m, a 2H:1V side slope and a grade not less than 0.5 % downstream.

7.5.2 MWD Construction and Cost Estimate

The construction of the mine waste dumps (SWD and NWD) will be performed in stages over the life of mine in accordance with the mine plan. The first stage will include clearing and grubbing, topsoil removal over the stage area (area dependent on the mine plan), installation of the underdrain (to the stage limit), and construction of the settling pond. As each subsequent stage is constructed, the stage area will involve clearing and grubbing, topsoil removal and extension of the underdrain to the stage limit.

The estimated construction quantities and cost estimates are summarised in Table 7-20. The actual construction will be performed either by mine operations or a contractor over several years as driven by the mine plan. The unit costs in Table 7-20 were based on the following:

- Site Clearance – based on the TSF Costing Rates
- Foundation Preparation – based on the TSF Costing Rates
- Excavation for sediment ponds and underdrains – based on rates from the WBHO construction estimate
- Waste rock placement for outlet drains – based on rates from the WBHO construction estimate
- Geotextile supply and placement for under drains – based on rates obtained from recent Golder projects

Table 7-20: Estimated Mine Waste Dump Construction Quantities and Cost Estimate

Item No.	Description	Unit	Quantity	Unit Rate (US$)	Amount (US$)
NORTH WASTE DUMP					
1	**SITE PREPARATION**				
1.1	**<u>Site Clearance</u>**				
1.1.1	Clear and grub trees and vegetation cover from entire footprint of waste dump facility stockpile within free haul distance of 500 m.	ha	53	5 600.00	296 800.00
1.2	**<u>Foundation Preparation</u>**				
1.2.1	Remove topsoil from entire footprint area to a depth of ~300 mm and stockpile within 1 km free haul distance.	m^2	518 815	1.12	581 072.80
	Carried to sum				877 872.80
2	**UNDERDRAINS AND SEDIMENTATION PONDS**				
2.1	**<u>Sediment Pond and Ancillary Structures</u>**				
2.1.1	Excavate to grade to form sediment pond and outlet channel	m^3	11 378	7.4	84 197.20
2.1.2	Place and compact selected waste rock to form sediment pond outlet structure	m^3	308	9.83	3 027.64
2.2	**<u>Underdrains</u>**				

Item No.	Description	Unit	Quantity	Unit Rate (US$)	Amount (US$)
2.2.1	Excavate to spoils grade 0.5 m depth channel along underdrains alignment	m^3	4 224	7.4	31 257.60
2.2.2	Supply and install 340 g/m² non-woven needle punched A6 geotextile	m^2	20 143	4.87	98 097.38
	Carried to sum				216 579.82
NORTH WASTE DUMP TOTAL					**1094 452.62**
SOUTH WASTE DUMP					
1	**SITE PREPARATION**				
1.1	**Site Clearance**				
1.1.1	Clear and grub trees and vegetation cover from entire footprint of waste dump facility stockpile within free haul distance of 500 m.	ha	99	5 600.00	554 400.00
1.2	**Foundation Preparation**				
1.2.1	Remove topsoil from entire footprint area to a depth of ~300 mm and stockpile within 1 km free haul distance.	m^2	995 993	1.12	1 115 512.16
	Carried to sum				1 669 912.16
2	**UNDERDRAINS AND SEDIMENTATION PONDS**				
2.1	**Sediment Pond and Ancillary Structures**				
2.1.1	Excavate to grade to form sediment pond and outlet channel	m^3	9 965	7.4	73 741.00
2.1.2	Place and compact selected waste rock to form sediment pond outlet structure	m^3	347	9.83	3 411.01
2.2	**Underdrains**				
2.2.1	Excavate to spoils grade 0.5 m depth channel along underdrains alignment	m^3	3 985	7.4	29 487.15
2.2.2	Supply and install 340 g/m² non-woven needle punched A6 geotextile	m^2	19 127	4.87	93 147.52
	Carried to sum				199 786.68
SOUTH WASTE DUMP TOTAL					**1 869 698.84**
WEST WASTE DUMP					
1	**SITE PREPARATION**				
1.1	**Site Clearance**				
1.1.1	Clear and grub trees and vegetation cover from entire footprint of waste dump facility stockpile within free haul distance of 500 m.	ha	16.9	5 600.00	94 640.00

Item No.	Description	Unit	Quantity	Unit Rate (US$)	Amount (US$)
1.2	**Foundation Preparation**				
1.2.1	Remove topsoil from entire footprint area to a depth of ~300 mm and stockpile within 1 km free haul distance.	m^2	169 100	1.12	189 392.00
	Carried to sum				284 032.00
2	**UNDERDRAINS AND SEDIMENTATION PONDS**				
2.1	**Sediment Pond and Ancillary Structures**				
2.1.1	Excavate to grade to form sediment pond and outlet channel	m^3	7 595	7.4	56 203.00
2.1.2	Place and compact selected waste rock to form sediment pond outlet structure	m^3	430	9.83	4 226.90
2.2	**Underdrains**				
2.2.1	Excavate to spoils grade 0.5 m depth channel along underdrains alignment	m^3	1 092	7.4	8 078.95
2.2.2	Supply and install 340 g/m² non-woven needle punched A6 geotextile	m^2	5 240	4.87	25 520.75
	Carried to sum				94 029.60
WEST WASTE DUMP TOTAL					**378 061.60**
COMBINED TOTAL					3 342 213.06
CONTINGENCY					334 221.31
GRAND TOTAL					**3 676 434.37**

7.6 PROJECT WATER BALANCE UPDATE

The water balance for the proposed Tulu Kapi gold mine in Ethiopia was developed by Golder Associates (Golder) for Nyota Minerals in 2012 (Golder, 2012) to support the EIA and the DFS. The project was to process 2.0 million tonnes of ore per annum over a 10-year period from an open pit. The project has since been taken over by KEFI Minerals who have re-assessed the DFS and have revised the project to process 1.2 million tonnes of ore per annum over a 13-year period.

Golder, as part of the DFS, constructed a dynamic site-wide water balance to simulate the proposed water circuits and volumes on the mine. The water balance together with the inputs and assumptions was documented in Golder (2012). The water balance model was applied with the reduced tonnages to update the water balance for inclusion in the DFS report. The Tulu Kapi Water Balance Update Report is included in Annexure 7-6.

7.6.1 Tulu Kapi Water-Related Infrastructure Circuits

The water-related infrastructure and features at Tulu Kapi include the pit, plant and primary crusher, the TSF, mine waste deposits, RWDD, and the attenuation dam. The water generated in the pit and run-off/seepage from the mine waste dumps (MWD) will be discharged to settling ponds/lagoons and released to the environment. The new layout includes three MWDs designated as the West, North, and South MWDs. The mine water circuit consists of the following facilities:

7.6.1.1 Tailings Storage Facility

The TSF will receive slurry from the plant and run-off from the upstream catchment area between the river diversion and the TSF. Water from the TSF will be pumped back to the plant via a barge/penstock system. Water is required by the plant at an average rate of 181 m^3/h. Prior to tailings disposal, two intermediate dams will be built within the TSF footprint, Phase 1A (809 000 m^3 capacity) and Phase 1B (226 000 m^3). Water will be collected in these dams to provide the plant with its start-up water requirements. Process water will be primarily sourced from the TSF pool return water. This will be supplemented with rain water inflow from the TSF and from the RWDD when necessary. The seepage volume of 10.4 m^3/h (2.9 L/s) collected in the TSF seepage pond will be pumped for use in the plant. As the growth of the seepage volume over time and the volume is relatively small, the seepage collection and use was not included in the modelling.

7.6.1.2 Raw Water Diversion Dam

Raw water will be pumped to the plant from the RWDD as clean make-up water, with some water being treated for potable use. The RWDD will receive clean water run-off from its natural catchment and will supply the plant clean water requirements at a rate of 26 m^3/h through start-up and the life of mine operations. The RWDD will also have some capacity to supplement the plant with water should the supply of return water from the TSF be insufficient during an extended dry season. Water at a rate of 11 m^3/h will be supplied to the offices/shops and 2.1 m^3/h will be supplied for drinking water to the mine camp. Part of the TSF catchment will be diverted to the RWDD and the Spillway/Diversion Channel to prevent flooding of the TSF.

7.6.1.3 Attenuation Dam

The attenuation dam and western diversion channel collects run-off from part of the TSF catchment area which includes the plant area. The water is conveyed along the western side of the TSF and discharged below the TSF wall. This reduces the volume of water that will have to be managed on the TSF.

7.6.1.4 Plant Area

Water is supplied to the plant from the RWDD (raw water) and TSF (return/process water).

7.6.1.5 Pit area

The pit will generate water by means of groundwater inflow and will also receive direct rainfall (catchment run-off is unlikely to reach the pit due to its elevated topography). Water that accumulates in the pit (including groundwater and rainfall) will be dewatered to settling ponds and discharged to the environment after settling.

7.6.1.6 Mine Waste Deposit

A basic balance has been compiled for the MWDs. Run-off will be retained within the deposits and associated settling ponds. The kinetic geochemical testing of the waste rock material and the low grade ore shows that in the short to medium term the material is likely to be non-acid generating. The discharges are likely to have elevated sulphate, nickel and manganese concentrations when compared to the Ethiopian drinking water guidelines.

7.6.2 Model Inputs – Water Requirements

The water requirements for the plant are given in Table 7-21.

Table 7-21: Plant Water Requirements

Water Requirement	Volume
Raw water requirement	26 m^3/h
Slurry water	206 m^3/h based on 137 t/h dry slurry mass at 40 % solids and a solids density of 2.8 t/m^3
Water in ore	6.8 m^3/h assuming 5 % moisture content in ore
Plant losses	8.0 m^3/h
Plant process demand make-up water requirement	181 m^3/h

7.6.3 Model Inputs – Waste Storage Facilities

Three MWDs are planned for the storage of the waste rock. The locations of the three MWDs are described in Section 7.5. The surface areas for the mine waste deposits were measured from the available LiDAR maps and are summarised in Table 7-22.

The run-off and seepage from the MWD will be collected in a drainage system and directed to settling dams located at the lowest point on the MWD perimeter. The settling ponds are sized to provide sufficient retention time to remove medium silt-sized particles for the 2 year 24-hour design storm of 49 mm.

Table 7-22: Measured Mine Waste Dump Areas

MWD	Area (ha)
MWD West	17
MWD North	53
MWD South	99
Total	**169**

7.6.4 Model Inputs – Dam Capacities

Dam capacities are indicated in Table 7-23.

Table 7-23: Proposed Tulu Kapi Water Storage Facility Details

Facility	Capacity (m^3)	Area (m^2)
RWDD	553 700	72 000
TSF Phase 1a Dam	809 000	88 000
TSF Phase 1b Dam	226 000	34 000

7.6.5 Operating Rules for the Model

The operating rules for the mine water management system are built into the model. The principles used for the model are summarised as follows:

7.6.5.1 Plant

Slurry is pumped from the plant to the TSF. The supernatant water will be pumped from the TSF via a barge to the plant process water storage pond. If this return water is insufficient to meet the 180 m^3/h requirement, the plant process water demand can be supplemented by raw water stored in the RWDD.

7.6.5.2 Tailings Storage Facility

The tailings footprint of the TSF changes over time in the model according to the following timeframes (based on the TSF construction schedule given in Epoch (2015)):

- 2018/01/01 0
- 2020/01/01 168 600 m^2
- 2024/01/01 350 100 m^2
- 2030/12/31 503 200 m^2

The volume of water in the pool on the TSF is determined using the following factors:

- Inflow run-off from the TSF beach (wet and dry)
- Inflow run-off from the surrounding TSF catchment and direct rainfall
- Process water recovery from the slurry water
- Outflow via the penstock/barge pump
- Offtake to the mechanical evaporators (if applicable)
- Evaporation and seepage

7.6.5.3 RWDD

Water is pumped from the RWDD to meet the plant's clean water requirements (26 m^3/h).

The inflows to the RWDD include direct rainfall and upstream catchment run-off (710 800 m^2).

The outflows include evaporation and seepage, as well as volumes pumped to the plant, offices/shops and mine camp.

Should the RWDD spill, the excess water is diverted via the spillway/diversion channel to the topographic drainage east of the TSF, and is released to the environment as clean water.

7.6.5.4 Attenuation Dam

The dam is not included in the model as the water stored in the dam is not used on the mine water system. The dam collects water for diversion to the west of the TSF.

7.6.5.5 Phase 1a and 1b Dams

These two dams are located within the TSF footprint, and will be used to accumulate process water for the plant start-up.

Accumulated water will be pumped to the plant as process water at an average rate of 180 m^3/h for start-up and subsequently during operations.

In terms of the water accumulated in the Stage 1B dam, the dam wall will be built with the capacity to decant water through a penstock. Prior to deposition of tailings into the Stage 1B dam, the mine management team will make a decision on how much water is required for the plant functions based on the amount of water on site at that stage, and decant the remaining water. Thereafter, the penstocks will be sealed when Stage 1B starts to receive tailings. In the current model, this water is released and not retained on the TSF.

7.6.5.6 Pit

The pit inflows are modelled to progress according to the phasing outlined by Snowden's pit designs and updated by Mining And Cost Engineering Pty Ltd (2015), who provided estimates of groundwater inflow per phase. The phases were moved forward in time to fit the current mine plan starting in January 2017.

Inflows to the pit include direct rainfall, groundwater inflow, run-off from the pit and its walls, and wall seepage.

Outflows include dewatering to the settlement ponds, evaporation and seepage.

Excess water will report to four settling ponds, each of 1 800 m^3 capacity (30 m length × 60 m width × 1 m depth).

7.6.5.7 Mine Waste Dump

The MWD receives direct rainfall, and loses water through seepage to groundwater, toe seepage, run-off, and evaporation.

Excess water (toe seepage, run-off) is assumed to report to settling ponds before release to the environment.

The kinetic geochemical testing of the waste rock material and the low grade ore shows that in the short to medium term the material is likely to be non-acid generating (Golder, 2013). The discharges are likely to have elevated sulphate, nickel and manganese concentrations when compared to the Ethiopian drinking water guidelines.

7.6.6 Model Results

Initial runs with the model showed that the TSF did not spill. The simulations showed that the TSF does not reach the full storage capacity based on the construction schedule for the TSF. The plot does however show that significant volumes of water (up to 900 000 m^3) will be stored on the TSF for periods of time.

The RWDD supplies the potable water requirements for the plant. The simulations showed that there is a 5 % (1 in 20 year) probability that the full potable water requirement and process water requirement for the plant will not be able to be supplied from the RWDD and the TSF. A backup source of water should be developed to supply water during these rare dry periods.

The following conclusions can be made as a result of this investigation:

- The modelling of the TSF water balance shows that the TSF can store up to 900 000 m^3 of water on the TSF.

- The maximum storage capacity for water allowed on the TSF has been calculated by Epoch Resources (DFS Tailings Design Report – Annexure 7-1). It is critical, however, that if large volumes of water need to be stored on the TSF, this is done according to the TSF design report to allow for adequate stability and safety of the TSF.
- There is a low probability (< 5 %) that the plant potable and process water requirements will not be able to be met from the RWDD and TSF. Consideration should be given to developing an additional water source (potentially through boreholes) or the use of pit water for process water make-up as a backup to augment the supply through the rare dry periods. If a local source is not available, production at the mine can be modified based on water availability during these infrequent dry periods.
- The capacity for storage and treatment/settling of water from the pit (dewatering) and run-off and seepage from the mine waste deposits should be assessed as mining and waste deposition progresses. A thorough plan for the treatment and release of water from these settling dams to the environment should be developed and implemented as part of the Environmental Management Plan. The water quality in the pit dewatering and mine waste deposit run-off settling ponds is expected to be neutral with elevated sulphate, nickel and manganese concentrations.
- The monitoring network should incorporate evaluation of the mine water system. It is recommended that the main focus be placed on the following:

  - The water levels in the various dams
  - Pit pumping
  - The monitoring of the barge return water from the TSF
  - Plant water intake and use

- Water balance modelling is an ongoing process and can be used to modify management and mitigation measures, based on updated flow and level monitoring.

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8.1 SUMMARY

8.1.1 Manpower Summary

It is anticipated that the majority of KEFI Minerals Plc's (KEFI's) workforce will be sourced locally and it is KEFI's policy to maintain this practice to the extent possible. It is likely that a large contingent of employees will be sourced from the TK, Gimbi, Ayra and Nekemte villages and towns. The development of skills required to operate a gold mine will be fostered by KEFI. There appear to be no constraints regarding access to a pool of unskilled and semi-skilled labour and the future development of a skills base in the region.

In order to effectively manage the operations at Tulu Kapi, a labour schedule was drawn up to include labour for mining, processing and administrative duties. This section will describe the labour complement that will be required to operate the Tulu Kapi Gold Project, inclusive of expatriates, Ethiopian national and local employees.

Figure 8-1 shows the overall management structure for the Tulu Kapi Gold Project.

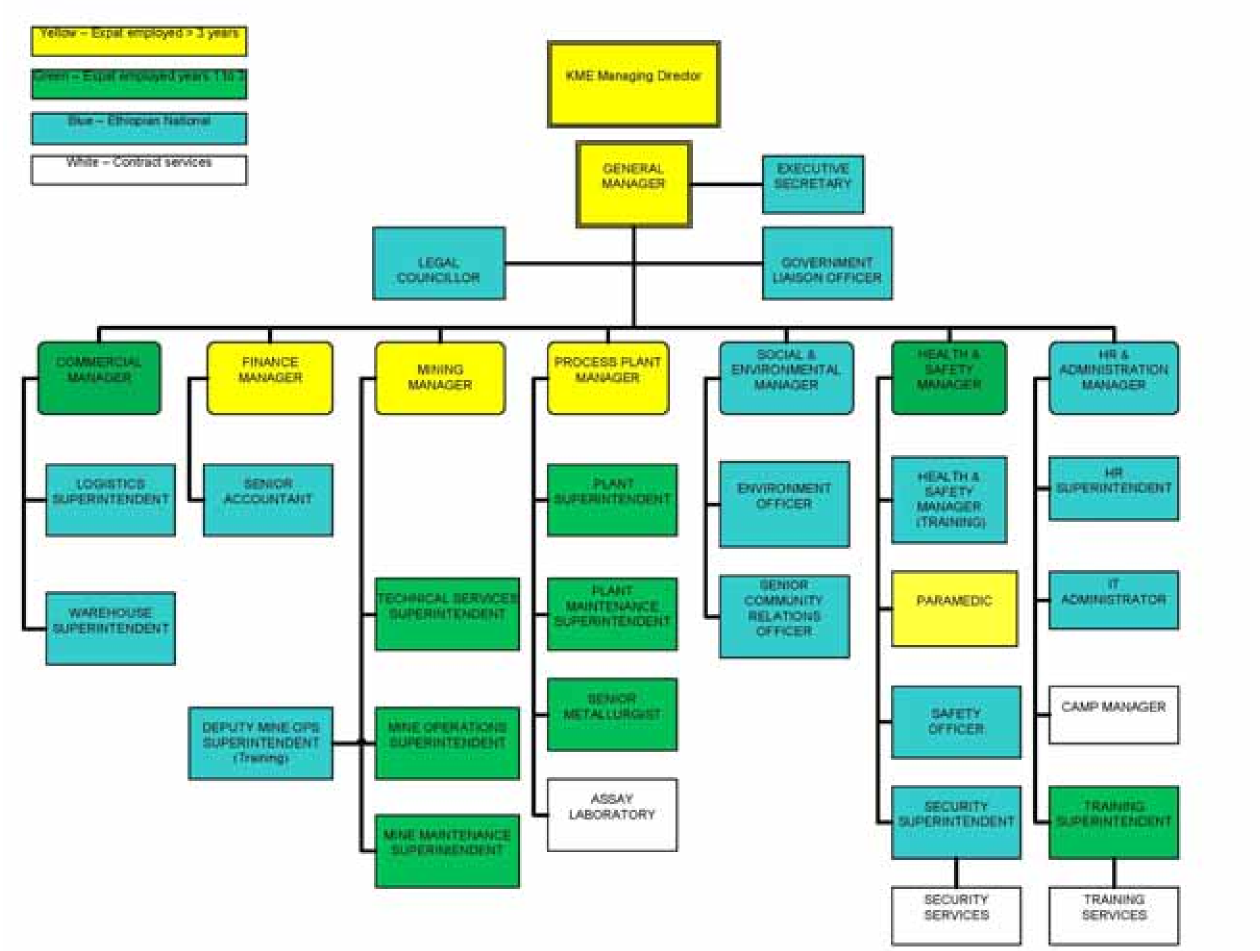

Figure 8-1: Tulu Kapi Overall Management Structure

The various management positions indicated in the structure shown above have been categorised using different colours according to the experience required for that position as well as the terms of employment. The four different colours are assigned as per the relevant descriptions in Table 8-1, Table 8-2 outlines the job grade categories used for the manpower structure.

Table 8-1: Colour Coding Key for Overall Management Structure

Colour	Description of Position and Experience Required
Yellow	Management position requiring significant technical knowledge and experience (10+ years) To be filled by an expatriate employee for a minimum of four years
Green	Management position To be filled by an expatriate initially and by an Ethiopian National after an appropriate period of training and development
Blue	Management position To be filled by an Ethiopian National from the outset
White	Position that will be outsourced to a contractor

Table 8-2: Patterson Job grade Categories

Paterson Job Grade	Local	Expat1	Expat2
	US$/a	US$/a	US$/a
A1	1 650	6 482	
A2	2 356	6 681	
A3	3 365	8 079	
B1	5 215	13 364	
B2	7 448	13 364	
B3	8 768	14 097	
B4	9 759	14 916	
B5	10 862	17 682	
C1	12 089	24 273	
C2	15 165	24 824	
C3	16 879	27 960	
C4	18 787	30 545	
C5	20 910	33 600	
D1	23 273	44 700	150 000
D2	27 398	47 200	170 000
D3	32 254	64 475	190 000
D4	40 459	78 392	210 000
D5	50 752	89 636	230 000
E1	63 663	91 273	210 000
E2	81 291	126 656	240 000
E3	117 450	150 455	260 000

8.1.2 Training Summary

Operational readiness in terms of human resources requires two things: recruitment and training. The recruitment of the personnel required for the development and operation of the Tulu Kapi project will be managed by KEFI and is planned to commence in the 4th quarter of 2015.

It is KEFI's intention to outsource all of the specialised training requirements to a training organisation. This will ensure that the training requirements will be correctly identified across the organisation and that suitable career paths for individuals will be developed to the mutual benefit of the employee and of KEFI.

8.2 MANPOWER

Manpower requirements were developed by Snowden (Mining), SENET (Process Plant) and KEFI (General and Administration). This includes defining the department equipment and staffing needs, shift patterns and rotation, and scheduling.

In assessing the manpower needs of the Tulu Kapi project, Meyer Hosking & Associates completed a demographics study, a salary survey, and reviewed the organisational structure. This forecast structure and personnel requirements for steady-state operation are outlined in the sections below.

The overall management structure for the Tulu Kapi gold project consists of seven departments:

- Mining Operations
- Processing Operations
- Finance
- Human Resources and Administration
- Commercial (Procurement and Supply)
- Health, Safety and Security (HSS)
- Environmental and Social

Security, Catering (Camp Management), and initial Training will all be outsourced services to contractors.

A total labour complement (excluding outsourced services) for the operational phase of the project is shown in Figure 8-2. This includes expatriate, national and local labour.

Within this structure, there will be a total of 30 management positions with 6 long-term expatriate employees and 85 temporary expatriate employees who will be employed for three years after initial commissioning.

Expatriates will be employed in supervisory positions to manage start-up and operate the mine. KEFI will ensure that all 85 expatriate employees will have a subordinate national employee appointed as an understudy to be mentored by them with the intention of developing them to replace the expatriates in the three years after initial commissioning.

Figure 8-2 shows the overall distribution of labour between the divisions (excluding outsourced services). Each division in the figure will be described in more detail below.

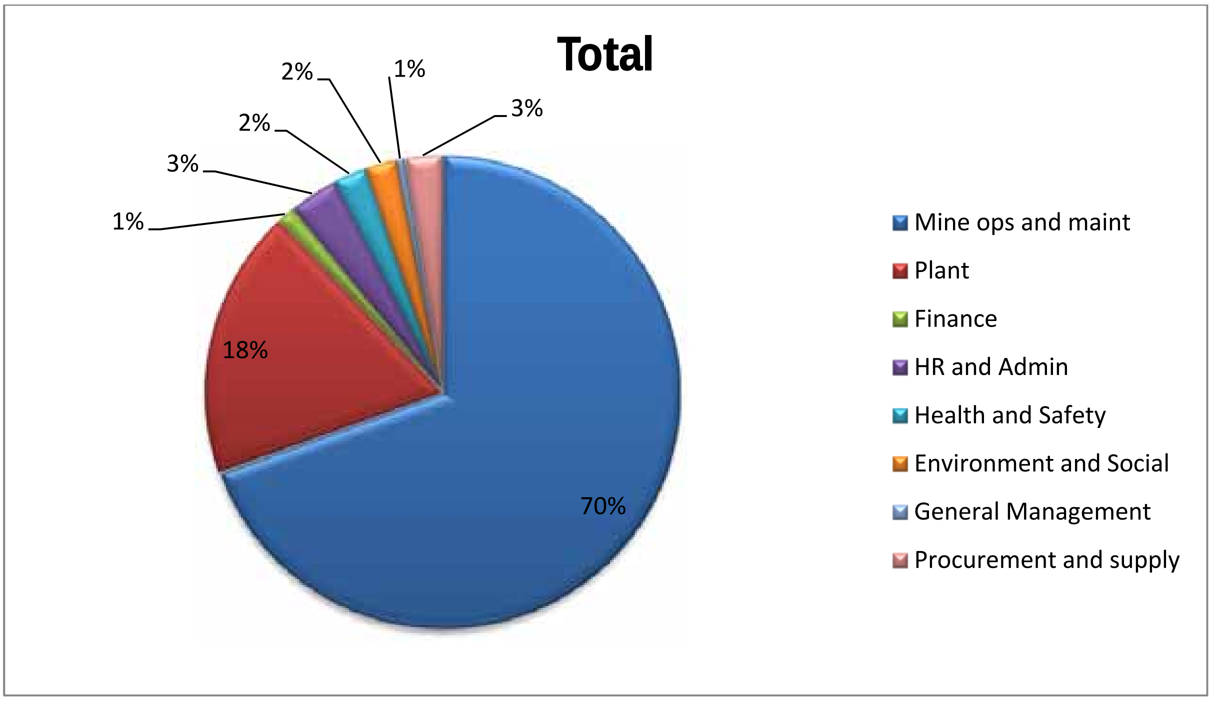

Figure 8-2: LOM Total Labour Distribution

In developing the Tulu Kapi staffing levels, the following assumptions were made:

1. Office employees work a 40-hour work week.
2. Operators will work on a 3 × 8-hour shift pattern, with operations running 24 hours a day.
3. Technical and maintenance staff will be on standby after hours on a rotational basis.
4. Nationals and expatriates that will stay on site will be based on a 6 weeks on, 2 weeks off basis.

8.2.1 Tulu Kapi Mine Management

Mine management for the Tulu Kapi mine will be headed by a general manager who will be supported by departmental managers as shown in Table 8-3. Some management positions will require expatriates for the life of mine and some will only require them for the first few years of operation, after which they will be handed over to a trained Ethiopian national. A national worker, trained under the guidance of an expatriate, will receive hands-on training in that specific role and will be able to replace the expatriate within a specified time.

Table 8-3 shows a list of positions that will be held by expatriates. It also shows the duration of service required from the expatriate before he is replaced by a national counterpart. Expatriate 2 positions will be expatriates with senior management experience in Africa, expatriate 1 positions will be expatriates with technical or supervisory experience in Africa. Will need additional operators to cover for annual Leave, sick days, training days to keep the mining fleet and department running efficiently.

Table 8-3: Expatriate Labour Summary and Duration of Service

Position	Job Grade	Source	Standard Workdays per Year	Number
Mine Manager	E3	Expat2	260	1
Technical Services Superintendent	D4	Expat2	260	1
Senior Mining Engineer	D4	Expat1	260	1
Chief Geologist	D5	Expat2	260	1
Senior Mine Geologist	D4	Expat1	260	1
Senior Mine Surveyor	D2	Expat1	260	1
Mine Operations Superintendent	D4	Expat2	260	1
Deputy Mine Operations Superintendent (Training)	C5	Expat1	260	1
Mining General Supervisor	D2	Expat1	260	2
Production Supervisors-Shift	C3	Expat1	260	4
Mine Trainer	C3	Expat1	260	4
Drill and Blast Supervisor	C4	Expat1	260	4
Blast Crew - Day Shift	B4	Expat1	260	8
Drill Operator	B4	Expat1	260	15
Mine Maintenance Superintendent	D4	Expat2	260	1
Mine Maintenance Supervisor	D2	Expat1	260	2
Product Specialist	D2	Expat1	260	2
Mine Maintenance Planner	D1	Expat1	260	1
Mine Maintenance Planner (Training)	C4	Expat1	260	1
Auto electrician	C1	Expat1	260	3
Welder	B4	Expat1	260	10
Machinist	B4	Expat1	260	10
Fitters - Shift	B4	Expat1	260	10
Total				**85**

8.2.2 Mining Department

The Tulu Kapi mine operations will be managed by the Mine Manager who will report to the General Manager. The senior technical positions in the mining management team will be held temporarily by expatriate employees, who will later be replaced by in-house trained Ethiopian nationals.

The Mining Department will include the following divisions:

- Technical services
- Mining operations
- Maintenance

The Mining Department organisational structure is shown in Figure 8-3 below (Yellow is expat 1, green is expat 2 and blue is a national position).

8.2.2.1 Mine Operations and Maintenance

The total mining operations and maintenance complement is estimated to be 241 personnel. As can be seen in Table 8-4 below, an expatriate, who will report to the General Manager, will be placed in the position of mine manager, and will be expected to continue in this position for a minimum of four years. The superintendent positions will initially be held by expatriates who will be shadowed by national workers. The superintendent expatriate roles will continue for three years, after which the position will be given to the shadowing national worker.

Table 8-4 lists the labour complement for the Mining Department and the distribution of expatriate, national and local labour for the LOM.

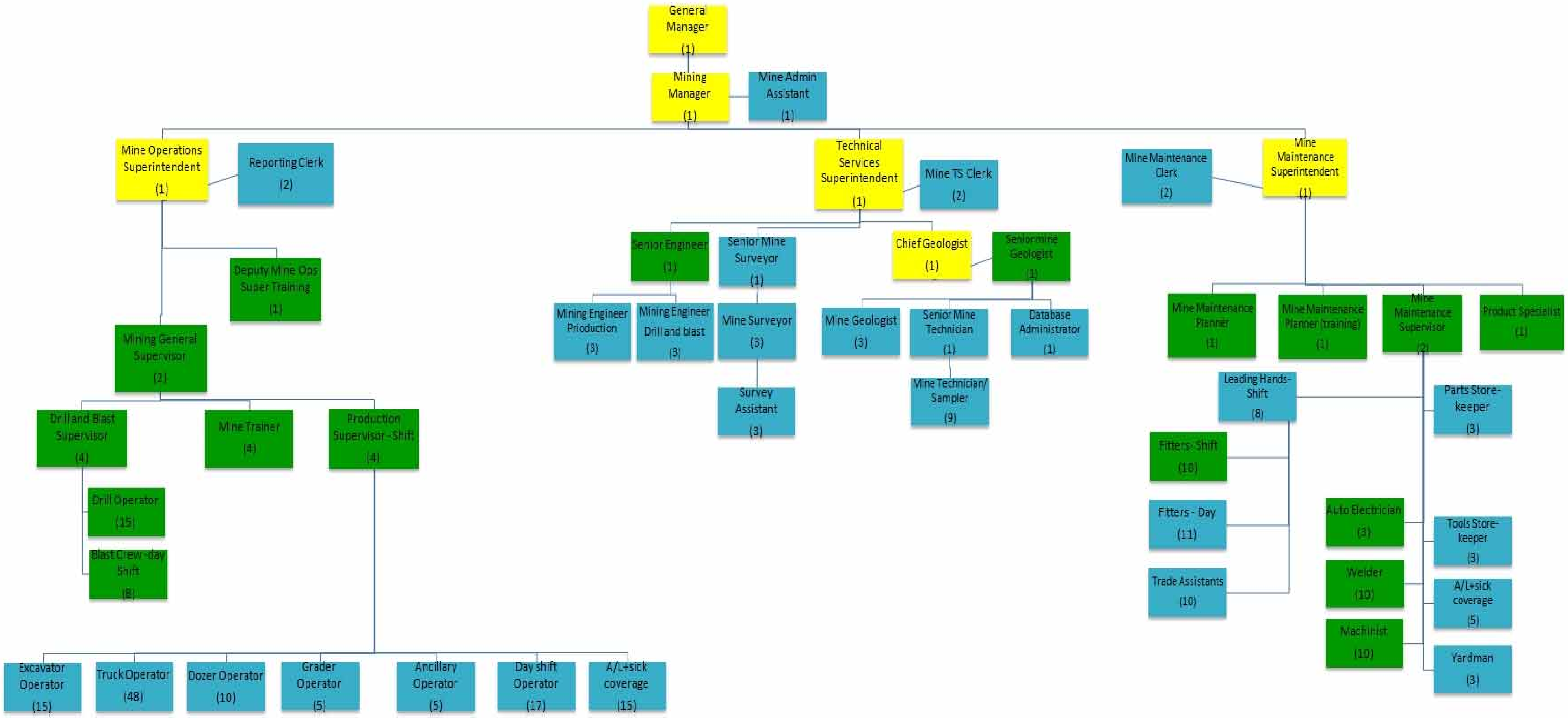

Figure 8-3: Mining Department Organisational Structure

Table 8-4: Mining Operations and Maintenance Labour Summary

Position	Job Grade	Source	Number
Mine Operations			
Mine Operations Superintendent	D4	Expat2	1
Deputy Mine Operations Superintendent (Training)	C5	Expat1	1
Mining General Supervisor	D2	Expat1	2
Production Supervisors-Shift	C3	Expat1	4
Mine Trainer	C3	Expat1	4
Drill and Blast Supervisor	C4	Expat1	4
Mine Reporting Clerks	A3	Local	2
Excavator Operator	B4	Local	15
Truck Operator	B3	Local	48
Blast Crew - Day Shift	B4	Expat1	8
Drill Operator	B4	Expat1	15
Dozer Operator	B4	Local	10
Grader Operator	B4	Local	5
Water Cart/Other Ancillary	B2	Local	5
Day-Shift Operators	B3	Local	17
A/L+sick coverage Mine Operations	B3	Local	15
Subtotal Mine Operations			***156***
Mine Maintenance			
Mine Maintenance Superintendent	D4	Expat2	1
Mine Maintenance Supervisor	D2	Expat1	2
Product Specialist	D2	Expat1	2
Mine Maintenance Planner	D1	Expat1	1
Mine Maintenance Planner (Training)	C4	Expat1	1
Maintenance Leading Hands - shift	C3	Local	8
Mine Maintenance Clerk	B1	Local	2
Auto electrician	C1	Expat1	3
Welder	B4	Expat1	10
Machinist	B4	Expat1	10
Fitters - Shift	B4	Expat1	10
Fitters - Day	B4	Local	11
Trades Assistants	B1	Local	10
Tool Storekeeper	B1	Local	3
Parts Storekeeper	B2	Local	3
Yardman	B1	Local	3
A/L+sick coverage Maintenance	B2	Local	5
Subtotal Mine Maintenance			***85***
Subtotal Mine Operations and Maintenance			***241***

8.2.2.2 Technical Services

The technical services will provide support to mining operations and oversee geological activities associated with mining.

Initially, this department will be headed by expatriates who will be shadowed by national employees. After three years, the expatriate will be replaced by the national worker who will continue to manage the activities without expatriate assistance. The labour schedule for technical services is shown in Table 8-5.

Table 8-5: Technical Services Labour Schedule

Position	Job Grade	Source	Number
Mine Technical Service Department			
Technical Services Superintendent	D4	Expat2	1
Mine Technical Services Clerk	B1	Local	2
Senior Mining Engineer	D4	Expat1	1
Mining Engineer - Production	D2	Local	3
Mining Engineer - Drill and Blast	D2	Local	3
Chief Geologist	D5	Expat2	1
Senior Mine Geologist	D4	Expat1	1
Mine Geologist	D1	Local	3
Senior Mine Technician	B4	Local	1
Mine Technician/Sampler	B1	Local	9
Senior Mine Surveyor	D2	Expat1	1
Mine Surveyor	C4	Local	3
Survey Assistants	B1	Local	3
Database Administrator	C3	Local	1
Subtotal Mine Technical Services			***33***
Total Mine			***274***

8.2.3 Processing Department

The processing plant is estimated to start production with 135 personnel, and maintain this level for the LOM.

The Plant Manager, who will report to the General Manager, will have significant technical knowledge and experience in the field, and will be expected to remain in this position for a minimum of five years. The short-term expatriate complement will be expected to remain in this position for the first three years of operation, during which they will be shadowed by Ethiopian nationals, who will be trained and developed to replace the expatriate once his/her term has come to an end. This will not reduce the number of department personnel in steady-state operations after the three years as additional nationals will be recruited to the junior positions.

The Processing Department will include the following sectors:

- Processing operations
- Maintenance and engineering
- Laboratory services

The Processing Department organisational structure, which includes processing operations, maintenance and engineering, and outsourced laboratory services, is shown in Figure 8-4 below.

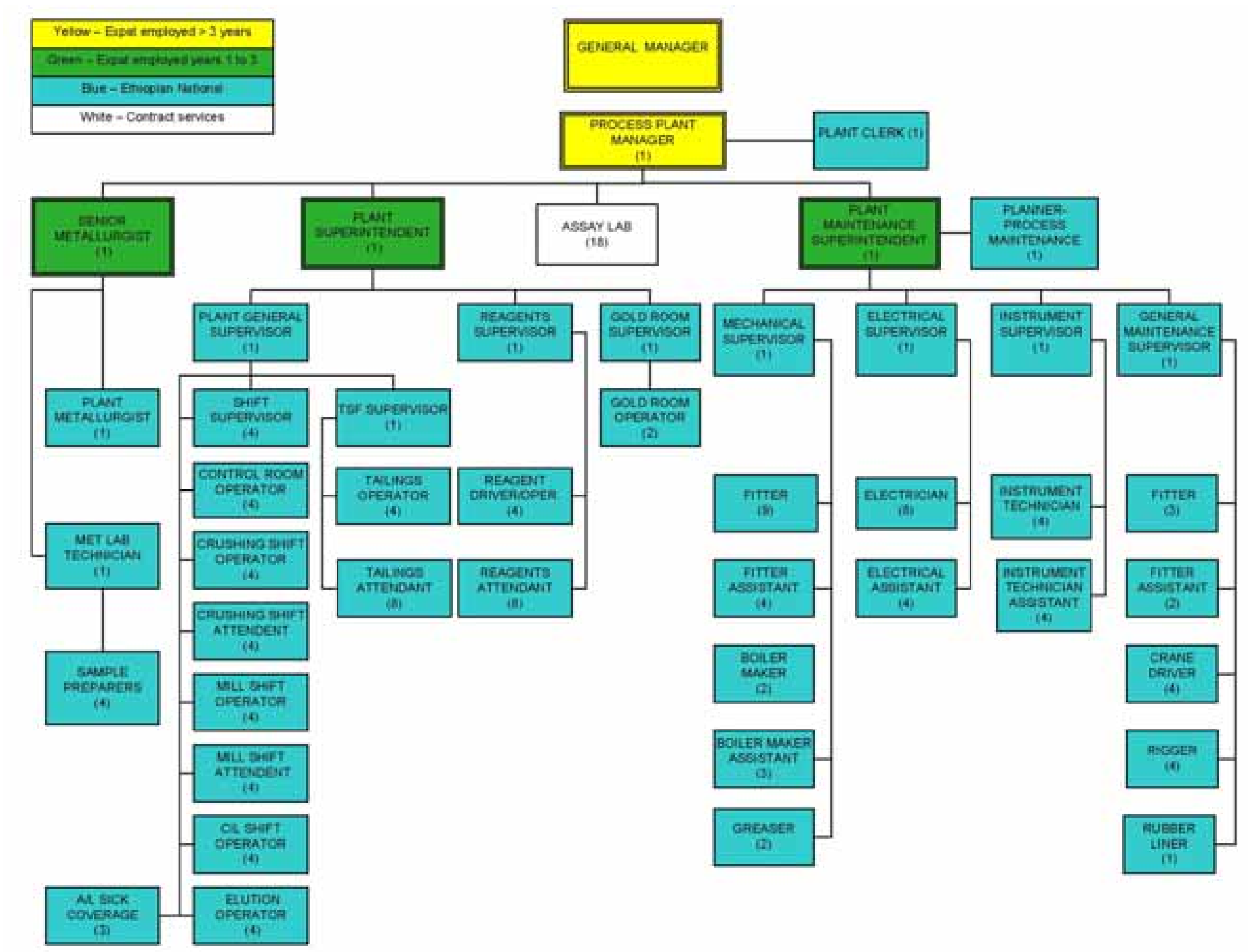

Figure 8-4: Processing Department Organisational Structure

8.2.3.1 Process Plant Operations

The plant will be managed by two superintendents, one dedicated to the plant operations and one to maintenance. They will report directly to the plant manager. The plant superintendent will be supported by a plant general supervisor, who will ensure that all process plant operating parameters are monitored and achieved on budget. Either the plant general supervisor or the senior plant metallurgist will fill the role as acting plant superintendent in the plant superintendent's absence. The plant general supervisor will oversee the day-to-day production problems as, or if, they should arise. Each of the three shifts will have a shift supervisor who will manage the operators that operate the plant during that shift.

8.2.3.2 Process Plant Maintenance

A plant maintenance superintendent, supported by a planning co-ordinator, mechanical supervisor, electrical supervisor, and instrumentation supervisor will ensure the availability of the plant.

The maintenance labour complement will consist of instrument technicians, electricians, boilermakers, mechanical fitters, and rubber liners that will be supported by assistants, riggers and heavy vehicle drivers for tower cranes and mobile equipment. The majority of the maintenance staff will work eight-hour day shifts, however, they will be expected to provide standby duties during night shifts and will be called as and when there are operational failures.
Table 8-6 lists the labour complement for the Processing Department and the distribution of expatriate, national and local labour for the LOM.

Table 8-6: Processing Department Labour Schedule

Position	Category	No. of Employees
Plant Operations		
Process Plant Manager	Expatriate 2	1
Plant Clerk	Local	1
Plant Superintendent	Expatriate for 3 years	1
Plant General Supervisor	National	1
Senior Metallurgist	Expatriate for 3 years	1
Plant Metallurgist	National	1
Shift Supervisor	National	4
Control Room		
Control Room Operator	National	4
Crushing		
Crusher Shift Operator	National	4
Attendant	Local	4

Position	Category	No. of Employees
Milling		
Mill Shift Operator	National	4
Attendant	Local	4
CIL, Elution		
CIL Shift Operator	National	4
Elution Operator	National	4
A/L+sick coverage	Local	3
Gold Room	Expatriate for 3 years	1
Gold Room Supervisor	National	1
Gold Room Operator	Local	2
Tailings		
TSF Supervisor	National	1
Tailings Operator	Local	4
Tailings Attendant	Local	8
Reagents and General Crew		
Reagents Supervisor	National	1
Reagents Driver/Operator	Local	4
Reagents Attendant	Local	8
Metallurgical Laboratory		
Metallurgical Laboratory Technician	National	1
Sample Preparer	Local	4
Subtotal		***76***
Plant Maintenance		
Plant Maintenance Superintendent	Expatriate for 3 years	1
General Maintenance Supervisor	National	1
Planner – Process Maintenance	National	1
Mechanical Supervisor	National	1
Electrical Supervisor	National	1
Instrument Supervisor	National	1
Plant Mechanical Maintenance		
Fitter	National	12
Fitter Assistant	Local	6
Boilermaker	National	2
Boilermaker Assistant	Local	3
Electrical Maintenance		
Electrician	National	8
Electrical Assistant	Local	4

Position	Category	No. of Employees
Instrumentation Maintenance		
Instrument Technician	National	4
Instrument Technician Assistant	Local	4
General Maintenance		
Crane Driver	National	4
Rigger	National	4
Rubber Liner	National	1
Greaser	Local	2
Subtotal		***60***
TOTAL PROCESS PLANT LABOUR		**136**

8.2.3.3 Laboratory

The laboratory, which will process mining and plant samples, will start up prior to the plant operations in order to process the mining grade samples in preparation for feeding the plant with ROM at a suitable grade. The Assay Laboratory is planned to be outsourced to a contractor. The laboratory will be operated and managed initially by an expatriate (from an external analytical laboratory service provider) for the first two years from start-up, after which the position will be held by a trained national employee. A complement of an additional 18 staff members has been recommended by the laboratory service provider. These positions will be filled by Ethiopian nationals from the outset.

8.2.4 General and Administration

The total general and administration (G&A) complement is estimated to be 90 KEFI employees and 142 contractors (catering, cleaning and security contractors). This will include the following departments:

- General management
- Finance
- Human resources and administration
- Commercial (procurement and supply)
- Health, safety and security (HSS)
- Environmental and social

The distribution of G&A labour (excluding outsourced services) for each of the G&A departments is shown in Figure 8-5.

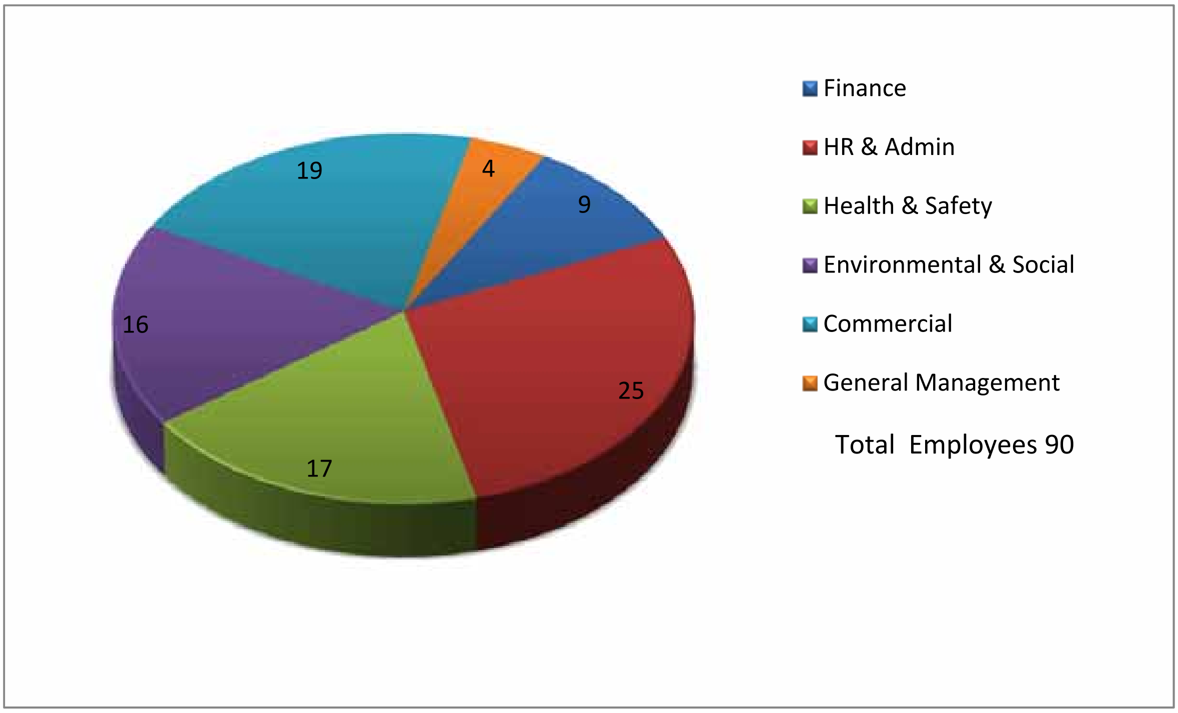

Figure 8-5: General and Administration Labour Distribution for Each Department

Table 8-7 shows the General and Administration labour schedule.

Table 8-7: General and Administration Labour Schedule

General Management	Category	No. of Employees (Year 1-3)	No. of Employees (4+ years)
MD/COO	Expatriate 1	1	1
Government Liaison Officer	National	1	1
Executive Secretary	National	1	1
Legal Counsellor	National	1	1
Subtotal		**4**	**4**

8.2.4.1 Finance Department

The Finance Department will be managed by the Finance Manager who will report to the General Manager. The forecast number of personnel making up the finance department is nine with one long-term expatriate appointment (the finance manager).

Figure 8-6 shows the organisational structure for this department.

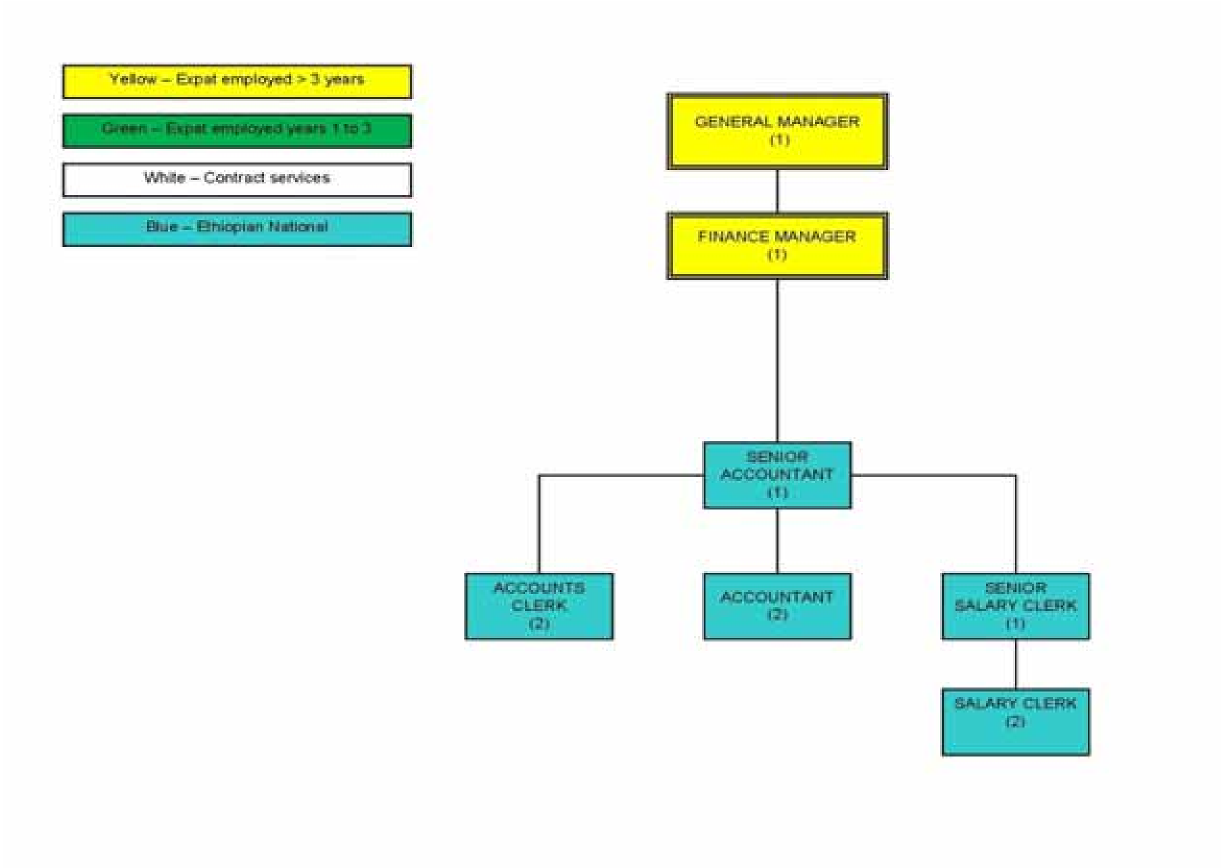

Figure 8-6: Finance Department Organisational Structure

Table 8-8 shows the labour complement for the Finance Department.

Table 8-8: Finance Department Labour Schedule

Finance	Category	No. of Employees (Year 1-3)	No. of Employees (4+ years)
Finance Manager	Expatriate 1	1	1
Senior Accountant	National	1	1
Accountant	National	2	2
Accounts Clerk	Local	2	2
Senior Salary Clerk	National	1	1
Salary Clerk	Local	2	2
Subtotal		**9**	**9**

8.2.4.2 Human Resources and Administration Department

The Human Resources Department will comprise training personnel, human resources and IT. The Human Resources and Administration Manager will be responsible for this department and report directly to the General Manager. The total forecast number of personnel after commissioning for this department is 25. Training and Catering services will be outsourced to a contractor. The Human Resources Department includes four divisions:

- Training and Development
- Employee Relations and Recruitment
- IT Administration
- Camp Management

Figure 8-7 shows the organisational structure for this department.

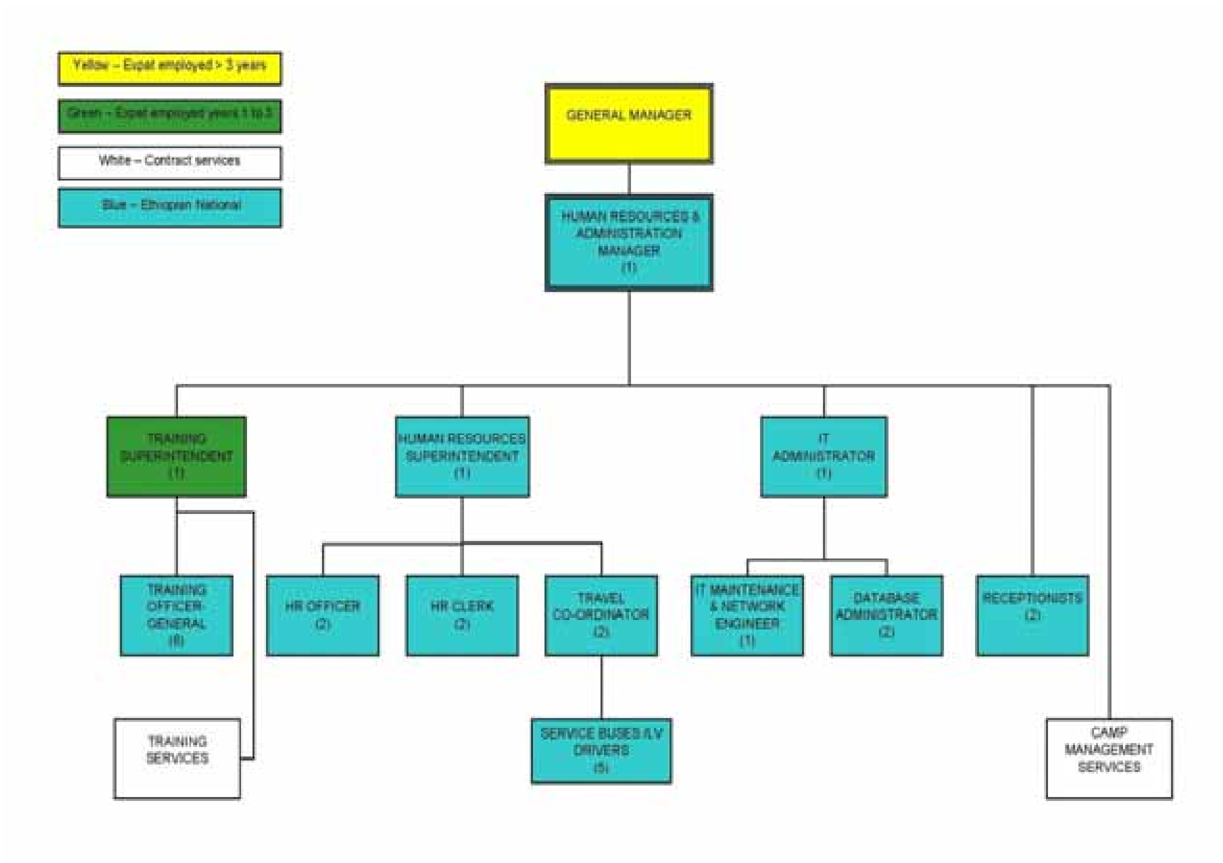

Figure 8-7: Human Resources Department Organisational Structure

Table 8-9 shows the labour complement for the Human Resources Department.

Table 8-9: Human Resources and Administration Department Labour Schedule

Human Resources and Administration	Category	No. of Employees (Year 1-3)	No. of Employees (4+ years)
HR and Administration Manager	National	1	1
HR Superintendent	National	1	1
HR Officer	National	2	2
HR Clerk	Local	1	1
Travel Co-ordinator	Local	2	2
Training and Development Superintendent	Expatriate for 3 years	1	1
Training Officer – General	National	6	6
IT Administrator	National	1	1
IT Maintenance and Networking Engineer	National	1	1
Database Administrator	National	2	2
Service Buses/LV Driver	Local	5	5
Receptionist	Local	2	2
Subtotal		**25**	**25**

8.2.4.3 Commercial (Procurement and Supply) Department

The Commercial (Procurement and Supply) Department will be responsible for the acquisition of goods and services required for mining and plant operations. This department will also manage the distribution of spare parts and stock items that will be held in the stores for maintenance or equipment failures.

The Commercial Department will be divided into two components: a warehouse division and a logistics and purchasing division. It is planned that there will be two expatriate appointments in this department, that of the Commercial Manager and the Chief Buyer. These positions will be filled by Ethiopian nationals within three years of commissioning. This will not reduce the number of department personnel in steady-state operations after the three years, as additional nationals will be recruited to the positions of Superintendent and Buyer.

Figure 8-8 shows the organisational structure for this department.

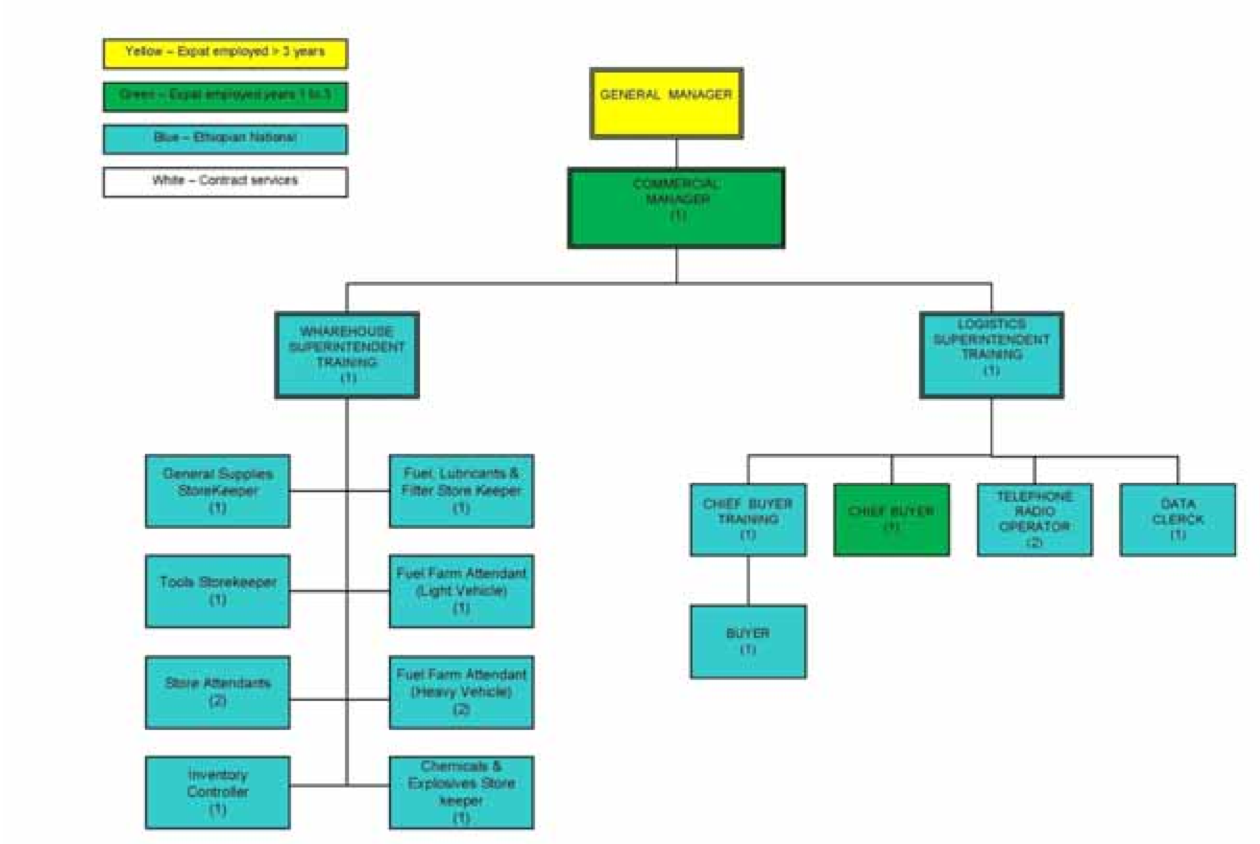

Figure 8-8: Commercial Department Organisational Structure

The distribution of expatriate, national and local employees within the Commercial Department is shown in Table 8-10.

Table 8-10: Procurement and Supply Department Labour Schedule

Commercial (Purchasing and Supplies)	Category	No. of Employees (Year 1-3)	No. of Employees (4+ years)
Commercial Manager	Expatriate for 3 years	1	1
Logistics Superintendent – Training	National	1	1
Chief Buyer	Expatriate for 3 years	1	1
Chief Buyer – Training	National	1	1
Buyer	National	1	1
Data Clerk	Local	1	1
Telephone/Radio Operator	Local	2	2
Warehouse Superintendent - Training	National	1	1
Fuel, Lubricants and Filter Storekeeper	Local	1	1
Fuel Farm Attendant (Light Vehicle)	Local	1	1
Fuel Farm Attendant (Heavy Vehicle)	Local	2	2
Tools Storekeeper	Local	1	1

Commercial (Purchasing and Supplies)	Category	No. of Employees (Year 1-3)	No. of Employees (4+ years)
Chemicals and Explosives Storekeeper	Local	1	1
General Supplies Storekeeper	Local	1	1
Store Attendant	Local	2	2
Inventory Controller	National	1	1
Subtotal		**19**	**19**

8.2.4.4 Health, Safety and Security (HSS) Department

The Health, Safety and Security Department is forecast to have a total of 17 employees with most employees reporting directly to the Health and Safety Manager, who in turn will report to the General Manager.

The security services will be outsourced to a contractor.

Figure 8-9 shows the organisational structure for this department.

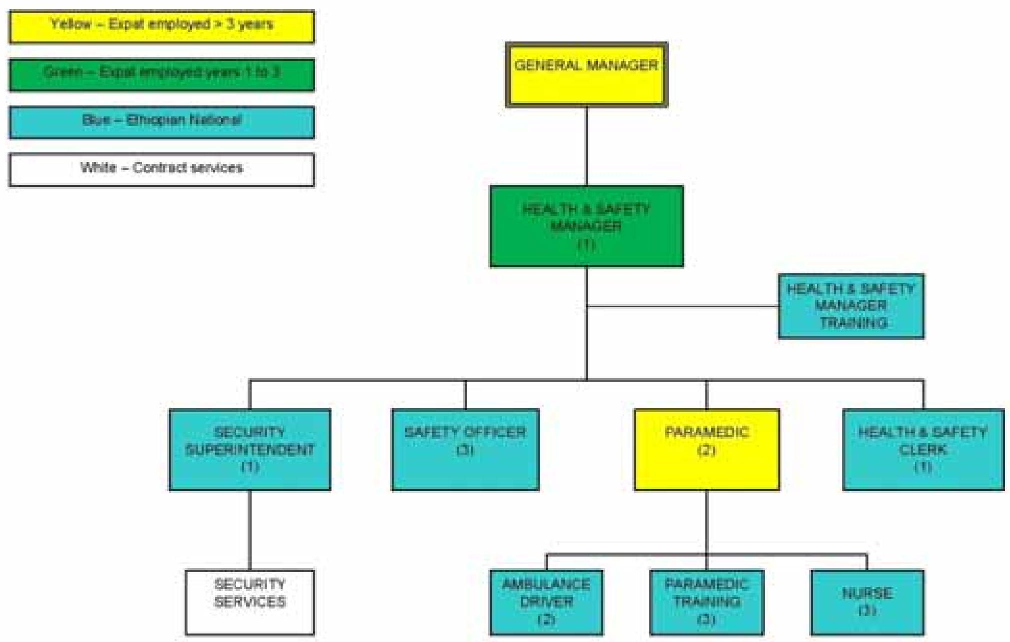

Figure 8-9: HSS Department Organisational Structure

The Health and Safety Manager will initially be an expatriate appointment and will be replaced within three years by the Health and Safety Manager in training, who will be an Ethiopian national. This will not reduce the number of department personnel in steady-state operations after the three years as an additional national will be recruited to a superintendent position.

Table 8-11 shows the distribution of expatriate, national and local employees within the HSS department.

Table 8-11: Health, Safety and Security Department Labour Schedule

Health, Safety and Security	Category	No. of Employees (Year 1-3)	No. of Employees (4+ years)
Health and Safety Manager	Expatriate for 3 years	1	1
Health and Safety Manager – Training	National	1	1
Security Superintendent	National	1	1
Paramedic	Expat 2	2	2
Paramedic – Training	National	3	3
Nurse	National	3	3
Ambulance Driver	Local	2	2
Safety Officer	National	3	3
Health and Safety Clerk	Local	1	1
Subtotal		**17**	**17**

8.2.4.5 Environmental and Social Department

The Environmental and Social Department is forecast to have a total of 16 employees to conduct all environmental management, mitigation and monitoring activities at the Tulu-Kapi gold mine throughout the construction, operation and closure phases, and to establish a cooperative relationship with communities living around the project area.

Figure 8-10 shows the organisational structure for this department.

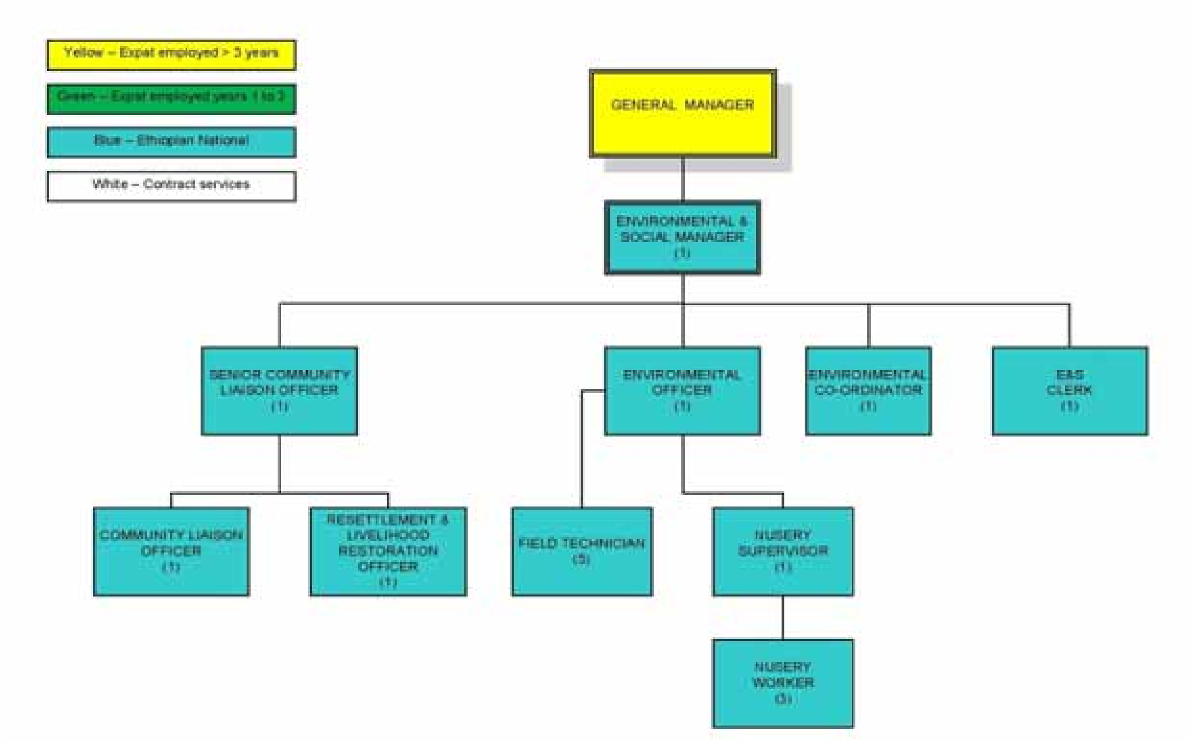

Figure 8-10: Environmental and Social Department Organisational Structure

Table 8-12 shows the distribution of national and local employees within the Environmental and Social Department

Table 8-12: Environmental and Social Department Labour Schedule

Environmental and Social	Category	No. of Employees (Year 1-3)	No. of Employees (4+ years)
Environment and Social Manager	National	1	1
Environment Coordinator	National	1	1
Environment Officer	National	1	1
Field Technician	National	5	5
Nursery Supervisor	Local	1	1
Nursery Worker	Local	3	3
Senior Community Relations Officer	National	1	1
Community Relations Officer	National	1	1
Resettlement and Livelihood Restoration Officer	National	1	1
Environment and Social Clerk	Local	1	1
Subtotal		**16**	**16**
Total G&A		**90**	**90**

8.3 RECRUITMENT, TRAINING AND LOCALISATION POLICY

To confirm its commitment to working in Ethiopia while building capacity, KEFI will source the majority of its workers from within the country. The group will undertake an operational preparedness (readiness) plan that has as its cornerstone the eventual training of nationals to fulfil all positions at the Tulu Kapi gold mining and processing facility.

It is KEFI's intention to outsource all of the initial specialised training requirements to a training organisation. This will ensure that the training requirements will be correctly identified across the organisation and that suitable career paths for individuals will be developed to the mutual benefit of the employee and of KEFI.

8.3.1 Operational Readiness

Operations readiness is the process that ensures the capability to operate the plant and equipment and to produce the end product in a safe and efficient manner. A large part of operations readiness consists of preparing the workforce for operations.

This seamless, low risk transition from construction to operations is made up of the following:

- Human resources readiness
  - Resource planning including recruitment strategy
  - Preparation of position descriptions
  - Career path management
  - Shift profiling
  - Training needs analysis
- Operational readiness
  - Development and implementation of risk-assessed operating procedures including Standard Operating Procedures (SOPs)
  - Process and operational training to achieve operational readiness for the start of commissioning
  - Training management system
- Maintenance readiness
  - Asset management plan
  - Maintenance strategy
  - Computerised maintenance management system (CMMS) set-up and loading of data
  - Critical spares analysis
  - Logistics and supply chain set-up

- o Site tooling
- o Training and mentoring of staff for maintenance management

8.3.2 Recruitment

Recruitment of the personnel required for operation of the Tulu Kapi project will be managed by KEFI's Human Resource Department.

In order to meet the planned commissioning and production targets, large-scale recruitment will need to be scheduled accordingly. Using the proposed timeline as guidance, it is assumed that KEFI will plan to begin management recruitment in the 4th quarter of 2015 (see Figure 8-11).

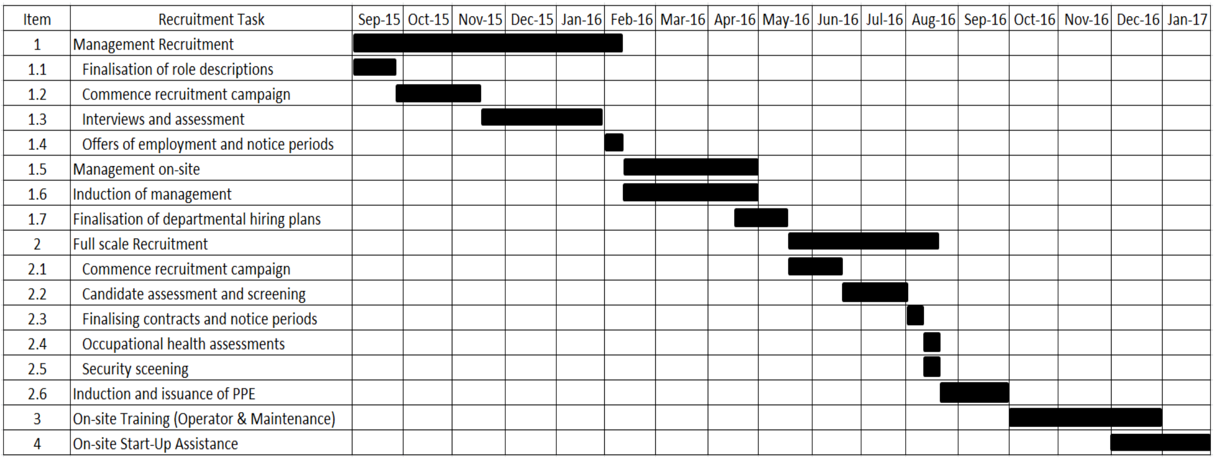

Figure 8-11: Recruitment Schedule

As 96 % of the workforce will be Ethiopian nationals, it is important to address whether sufficiently skilled and experienced individuals are available in-country. An assessment of the current pool of country labour for the mining industry was covered by a demographics study carried out by Meyer Hosking & Associates (see Annexure 8-1).

Although the number of individuals graduating from tertiary studies in mineral industry related fields is increasing and there are a number of supporting industries which also contribute to the total pool of skilled individuals that may be recruited by mining companies, and recruitment of qualified people for most roles will be possible, it will be beneficial for KEFI to employ expatriates to train and mentor Ethiopian workers so they may be able to acquire the necessary skills to be appointed into higher responsibility positions.

8.3.3 Training

As the potential workforce will largely be inexperienced in gold mining operations, training will be an essential component of the operational readiness tasks.

The training will be a computer-based training system and train-the-trainer programme followed by an on-the-job training programme.

On-the-job training is an important aspect of the training programme. Adults learn tasks predominately by demonstration and practice. This is also a key learning strategy employed for competency development for on-site trainers.

On-the-job (ONJ) training is vital in the transfer of knowledge from one operator to another. During ONJ training, KEFI staff at the processing plant facility are trained and mentored by experienced professionals. This process allows the professional to pass on critical information to enhance decision making for the new team. ONJ training also allows KEFI personnel to obtain a broader understanding of the upstream and downstream effects of their actions in the plant during real-time situations. The use of this strategy also allows for the identification of KEFI high-potential candidates who can be developed for leadership positions. Specialists will mentor to develop effective decision-making capability and pass on effective operating knowledge to the KEFI operators and supervision team.

Further information on the training programme and work process flow can be found in Annexure 8-2 and Annexure 8-3.

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SECTION 9 Project Infrastructure

Tulu Kapi Gold Project
Definitive Feasibility Study

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9.1 INTRODUCTION

The selected Tulu Kapi site is an undeveloped mining site with limited existing infrastructure consisting of the existing exploration camp. The proposed infrastructure will support the mining, processing and construction operations. The main infrastructure required for the development of the project will be the following:

- Mine facilities
- Process plant facilities
- Access roads within the mine licence area
- Power supply
- Power distribution
- Control, instrumentation and communications
- Temporary offices
- Construction camp
- Security
- Firefighting
- Social office infrastructure

This section details the proposed facilities for development within the mining licence area. Refer to the overall project layout in Annexure 9-1.

9.2 MINE FACILITIES

The following mine facilities have been provided (refer to Annexure 9-2 for layout drawings of the Mine Infrastructure Terrace):

- Haul roads
- Mine workshop
- Mining equipment refuelling facility
- Explosives magazine
- Mine administration building (including furnishings)
- Mine clinic
- Main stores/warehouse
- Potable water distribution
- Mine infrastructure water
- Sewage treatment and disposal

9.2.1 Haul Roads

Details of Haul Roads have been covered in Section 5.

9.2.2 Mine Workshop

A 1 240 m^2 workshop facility will be constructed on the mine infrastructure terrace to enable repair, servicing and maintenance of the mining fleet as well as maintenance of the mining and process plant equipment.

The workshop facility provides separate mining fleet maintenance and equipment maintenance areas.

The mining fleet maintenance area consists of the following:

- Tyre changing and storage facilities, including a compressor room
- Tools storage area
- Parts storage area
- Lubrication bay
- 3 vehicle maintenance bays
- 5 offices and a document storage room

The equipment maintenance area consists of the following:

- Lubricant storage area
- Equipment maintenance and repair workshop
- Ablution facilities
- Crib room
- 3 offices

Refer to Annexure 9-3 for the mine workshop drawings.

A slab has been allowed for alongside the workshop to facilitate the maintenance of light vehicles.

An outdoor wash bay equipped with four high-pressure water sprayers and a sloped concrete pad to an oil/water separator will be provided.

9.2.3 Mining Equipment Refuelling Facility

The fuel storage facility, which is situated adjacent to the Mine workshop, will have sufficient capacity for approximately one month's supply for the mining fleet, estimated to be approximately 400 m^3 based on an approximate consumption of 15 000 L per day, along with reserve capacity for emergency pumps and generators.

At present a proposal has been received through negotiation with a global fuel supply company to provide this facility and supply fuel (AGO - Automotive Gas Oil) and lubricant to Tulu Kapi.

The global fuel supply company is able to supply all necessary lubricants including diesel engine oil, transmission oil, steering oil, grease, brake fluid, coolant, hydraulic and gear oil, compressor oil, pneumatic tool oil, and heat transfer oil.

Based on the current proposals, the fuel supplier will provide and establish sufficient storage for an initial 150 m^3 at Tulu Kapi along with high flow rate dispensing pumps, services for used oil collection.

In addition the fuel supplier will ensure the necessary QC protocol on site to maintain the quality and cleanliness of fuel distribution provide a used oil analysis service to monitor service intervals and efficiency, and used oil collection and disposal service.

Diesel fuel will be stored in double-skinned, below ground tanks in a designated fuel compound with re-fuelling station. Tanks will have an external fuel gauge and appropriate signage.

Fuel will be delivered by 40 000 L road tankers at a sufficient rate to ensure that supply is maintained.

A mobile fuel vehicle and a mobile lubricant vehicle will also be used for the refuelling and servicing of tracked equipment (drills, excavators, loaders and dozers) in the field. This is to ensure that this equipment does not waste time tracking to be re-fuelled and serviced.

9.2.4 Explosives Magazine

The magazine infrastructure will be provided by the explosives vendor as part of the down the hole service. The costs will be recovered as a monthly fee for the infrastructure. The costs do not include site preparations and any concrete required. An estimate was compiled for the preparation of the surface magazine and emulsion manufacturing facility, including site preparation and compaction, fencing, earth bunds and concrete. Costs were taken from unit costs used in the SENET estimate for other infrastructure.

The total estimated cost to prepare the magazine site for the contractor was $623 000.

9.2.5 Mine Administration Building

This section should be read in conjunction with the mine infrastructure administration building drawing in Annexure 9-4.

The administration building will be a single-storey building located on the Mine Infrastructure Terrace and will be of prefabricated “Chromadek” panel construction.

The building has been sized to accommodate 63 staff members and will include general areas for engineering, geology, mining and administration personnel, housed in an open-plan office design and will include offices for the following personnel:

- General Manager
- Mine Manager
- Technical Services Superintendent
- Finance Manger
- Administration and Human Resources Manager

9.2.6 Mine Clinic

This section should be read in conjunction with the mine clinic building drawing in Annexure 9-5.

The clinic will be of prefabricated “Chromadek” panel construction, and will be located on the mine infrastructure terrace, alongside the mine administration building.

The clinic building will comprise the following:

- Ambulance garage
- Waiting room
- Emergency treatment room
- Doctor's room
- Dispensing room
- Nurses' room
- Rest room
- Laboratory
- Staff room
- Dressing room
- Store
- File room
- Ablutions
- Wash room

The clinic equipment will be capable of advanced life support and will include advanced airway and cardiac equipment. The consultation room will provide equipment to conduct medical screening of employees, general consultations, and minor procedures.

9.2.7 Mine Warehouse (Stores)

This section should be read in conjunction with the mine warehouse building drawings in Annexure 9-6.

A 1 170 m² enclosed steel structure warehouse will be provided on the mine infrastructure terrace to store spares for the mining plant and equipment, and for the process plant. Suitable shelving and racking will be incorporated in this building to store and manage the stored items. An unfenced laydown area is located adjacent to the mine store.

A 312 m² stores management building will be integrated with the stores building and will be of prefabricated "Chromadek" panel construction. This building incorporates the following:

- 138 m² lock-up storage room with a steel-float finish floor
- 10 m² stores manager's office
- 18 m² training/library/boardroom
- 80 m² open-plan office
- 40 m² crib room
- Male and female ablutions

9.2.8 Mine Infrastructure Water

9.2.8.1 Raw Water

Detailed information can be found in Section 7.

9.2.8.2 Fire Water

The raw water storage tank will also provide capacity for the fire water system. This will be achieved by raising the raw water outlet nozzle to ensure that the minimum fire water volume of 350 m³ is always available (calculated in accordance with SENET standards). There will be an electric and diesel-powered fire water pumping system. The electric pump will be used in the event of a fire, and the diesel pump will be a backup in case of electrical failure. A jockey pump will be provided to maintain the pressure in the fire water header during normal plant operations. An alarm will be sounded at the plant site in the case of low system pressure.

The fire water system will consist of a buried fire water ring-main and hydrant system on the mine infrastructure terrace. Hose cabinets will be placed at the fire hydrant locations, supplemented with portable fire extinguishers placed within the infrastructure buildings.

Each containerized MCC will be equipped with four smoke detectors, the associated fire detection panel and a siren. On activation of the smoke detectors, the local alarm will be activated, and an alarm signal will be relayed to the plant control room.

9.2.8.3 Potable Water

The containerised 6 m³/h potable water treatment plant will be supplied from the raw water storage tank, and will comprise filtration, reverse osmosis, and the relevant chemical dosing.

Details of the raw water quality analysis used by the vendor to select the water treatment plant are included in Annexure 9-7.

The treated water will be stored in an 80 m^3, above-ground potable water storage tank adjacent to the raw water storage tank. Potable water will be pumped to the following areas:

- Mine Workshop
- Mine Administration Building
- Mine Clinic
- Mine Warehouse

9.2.9 Mine Infrastructure Sewage Treatment

A 30 m^3/h modular sewage treatment plant will be provided on the mine infrastructure terrace for the treatment and disposal of the sewage generated. This is sized for a maximum capacity of 200 people, assuming 150 litres per day per person.

The technology selected is compact, simple and robust and uses a high efficiency combination of return-activated sludge plus submerged aeration media to purify effluent through various interlinked stages. This provides optimised nitrification and effluent quality to a standard that complies with the requirements of the South African Department of Water Affairs (DWAF) for the release of treated effluent back into the environment, in accordance with the General Limit Values in terms of Section 39 of the National Water Act, 1998 (Act No. 36 of 1998).

9.3 PROCESS PLANT FACILITIES

This section should be read in conjunction with the process plant layout drawing in Annexure 9-8. The processing plant and administration facilities on the process plant terrace shall include the following:

- Plant and administration buildings (including furnishings)
- Process plant access roads
- Process plant site drainage
- Waste management
- Process plant water
- Sewage treatment and disposal
- Transport

9.3.1 Plant and Administration Buildings

9.3.1.1 Plant Security Office and Change House

This section should be read in conjunction with the plant security office and change house drawing in Annexure 9-9.

A prefabricated, "Chromadek" panel, security office/change house block will be constructed at the main access to the plant and will include a security office, change house, laundry, first-aid room and dining/conference room.

Personnel access control will be monitored through the security office.

The change house will contain a male 'clean' change area consisting of lockers and benches provided for the process plant staff to store their clothes when they arrive for their shift. The male staff will then move through a search zone into the 'dirty' change area where they will change into their work clothes and proceed into the medium security area on the way to the process plant. At the end of shift, the male staff will return to the 'dirty' change area, remove their dirty work clothes, which will be washed in the adjacent laundry, shower and then proceed through the search area to the 'clean' change area where they will retrieve their own clothes.

The change house has been sized for 25 shift workers passing through the change house per shift, with three shifts per day and one shift team on vacation leave. 50 lockers have been provided in the 'dirty' change area, and a further 50 lockers in the 'clean' change area to ensure one locker per shift worker.

The following will be provided in the 'dirty' change area:

- 6 showers
- 3 toilets
- 2 urinals
- 3 wash hand basins

The change house will also consist of a female area, which will be provided with the following:

- 6 double lockers (a total of 12)
- 2 showers
- 1 toilet
- 1 wash hand basin

A fully equipped laundry room (3 750 mm × 5 600 mm), where all the overalls from the shifts will be washed, will be provided adjacent to the change house.

A first-aid room (4 850 mm × 4 500 mm) will be provided for the treatment of minor injuries sustained within the process plant, or as a holding room before evacuation from the process plant site.

A dining room/conference room (10 100 mm × 6 700 mm) designed to accommodate 25 shift workers will be provided. A section of the room can be partitioned off to form a conference/training room.

9.3.1.2 Plant Administration Building

This section should be read in conjunction with the plant administration building drawing in Annexure 9-10.

A prefabricated, "Chromadek" panel construction, administration building will be provided for the process plant management personnel.

This building will comprise the following:

- 17 m^2 Plant Manager's office
- 22 m^2 Mechanical and Electrical office
- 12.5 m^2 Metallurgists' office
- 2 × 12 m^2 Plant Supervisors' offices
- 11 m^2 Store room
- 7.5 m^2 Kitchenette
- Male and female ablutions

9.3.1.3 Plant Workshop

This section should be read in conjunction with the plant workshop drawings in Annexure 9-11.

The plant workshop consists of two workshop bays, located adjacent to one another. One of the workshop bays will be for mechanical maintenance requirements, and the other bay will be for electrical and instrumentation maintenance requirements.

Each bay is created by two 12 m containers spaced 6 m apart and enclosed with steel trusses and roof sheeting. The covered workshop area for each bay is 12 m × 6 m = 72 m^2 (Total = 144 m^2).

The 12 m containers will be converted to form the following:

- 2 insulated offices
- 2 storage areas with shelving
- 2 workshops including a work bench

The workshop contained within the process plant area is for minor maintenance only. The equipment maintenance area within the mining workshop shall be used for more extensive process plant maintenance.

9.3.1.4 Plant Reagents Store

This section should be read in conjunction with the plant reagents store drawing in Annexure 9-12.

The reagents store is 27 m × 15 m, and will be located within the process plant area to the south of the reagents make-up area. Store Area B and Store Area D, as described below, will be located within the reagents building, and be segregated by a partition to separate cyanide and caustic soda from the other reagents. The reagents store will comprise a steel clad structure and concrete floor slab, complete with drainage and spillage handling facilities.

A concrete paved area will be provided on both sides of the reagents store to facilitate loading into the store, and movement from the store to the reagents make-up area.

Three months' stockholding of the reagents has been assumed when sizing the stores. The plant reagents consumptions and storage requirements are detailed in Annexure 9-13.

Reagents will be accommodated in the storage areas as set out below.

9.3.1.4.1 Store Area A: Hydrated Lime

The hydrated lime requires a storage area of 198 m^2 assuming that the lime bulk bags are stacked two high. A concrete slab of 14 m × 15 m will be provided for the storage of lime and it will be stored under a tarpaulin.

9.3.1.4.2 Store Area B: Acids/Bases/Toxic Reagents

Store Area B will be under cover and located within the reagents store. It will contain copper sulphate, sodium metabisulphite, antiscalant, silica, borax and sodium carbonate, and will require a total area of 180 m^2. An area of 15 m × 15 m has been allocated for this store.

9.3.1.4.3 Store Area C: Flammables

Store Area C will be within one 40 foot container and located to the east side of the reagents store area. Only activated carbon, which will require a total area of 9 m^2, will be stored within this container.

9.3.1.4.4 Store Area D: Cyanide

Store Area D will be under cover and located within the reagents store. It will contain sodium cyanide and caustic soda, and will require a total area of 85 m^2. An area of 12 m × 15 m has been allocated for this store. The sodium cyanide will be stored in boxes that can be stacked three high.

9.3.1.4.5 Store Area E: Hydrochloric Acid

Store Area E will be two 40-foot containers located alongside the reagents store used to store hydrochloric. A total area of 34 m^2 is required to store the drums of hydrochloric acid stacked two high.

9.3.1.5 Plant Assay Laboratory

This section should be read in conjunction with the plant assay laboratory drawings in Annexure 9-14.

A fully equipped assay laboratory will be included in the process plant area. The laboratory will perform a daily analysis of mining and process samples.

The assay laboratory building will consist of a steel portal frame structure with steel roof trusses and roof sheeting. Side wall sheeting will tie into two 40 foot container conversions and one 20 foot container conversion positioned around the perimeter of the building. Steel columns will be supported on reinforced concrete foundations and a concrete surface bed will form the laboratory floor.

SGS (Société Generale de Surveillance) has submitted a proposal to manage the laboratory on behalf of KEFI Minerals. If awarded the contract, SGS will provide laboratory design and engineering services along with all the equipment required for the sample preparation and analysis.

9.3.1.6 Plant Control Room

A converted shipping container located on top of the CIL tanks will be used to provide a dedicated plant control room. The control room will be suitably furnished, and will house the SCADA system and provide operators with an elevated view of the entire plant.

9.3.2 Plant Access Roads

The total length of roads within the process plant terrace is approximately 550 m and these roads are nominally 6 m wide. The roads will be constructed by ripping and compacting the road bed to a depth of 200 mm, and topping with 150 mm of gravel all-weather wearing coarse material. Drainage ditches and culverts will be placed in accordance with the drainage requirements.

These roads will provide access to the plant infrastructure buildings, as well as the process plant equipment and helipad.

9.3.3 Helipad

A 35 m diameter helipad (helicopter landing zone) is located immediately north of the gold room within the process plant area. The helipad will be used to support helicopter transport of gold bullion from the plant directly to Addis Ababa.

9.3.4 Plant Site Drainage

The process plant area will be constructed with berms and side drainage as required to ensure that any water run-off not contained in the bunded areas and returned to the process is diverted to the TSF. The plant terrace shall be constructed to a slope of 1:200 from the highest point on the terrace sloping towards the TSF valley.

The sections below detail the process plant site drainage.

9.3.4.1 Berms

Storm water cut-off berms will be constructed to prevent storm water from entering lower lying areas from areas with a higher elevation. The berms will be constructed using the material excavated from the bulk excavations when the bulk earthworks are carried out.

9.3.4.2 Side Drains

Surface drainage of the plant area will be achieved using side drains. The surface of the plant shall be sloped to allow the water to flow freely away from the plant. The plant roads will be built to have a single cross fall between 2 % and 4 % in the direction of the side drain.

9.3.5 Waste Management

The chosen waste management plan is for the collection and centralisation of all domestic waste.

Used oil and disposal services will be provided by the fuel supplier as part of their contract. Construction debris and other inert waste will be placed in designated cells and covered, within the waste rock dump. Solid domestic waste from the mine facilities will be recycled and re-used in an approved manner, where feasible. Other solid waste will be placed in waste receptacles and containers for disposal through waste collection contractors or suitable incinerator. A comprehensive waste management plan will be developed for the project.

9.3.6 Plant Water

9.3.6.1 Raw Water

Mine infrastructure raw water will be pumped from the raw water dam to the raw water storage tank on the mine infrastructure terrace. The raw water storage tank will have a capacity of 500 m^3.

9.3.6.2 Fire Water

The raw water storage tank will also provide capacity for the fire water system. This will be achieved by raising the raw water outlet nozzle to ensure that the minimum fire water volume of 350 m^3 is always available. There will be an electric and diesel-powered fire water pumping system. The electric pump will be used in the event of a fire, and the diesel pump will be a backup in case of electrical failure. A jockey pump will be provided to maintain the pressure in the fire water header during normal plant operations. An alarm will be sounded at the plant site in the case of low system pressure.

The fire water system will consist of a buried fire water ring-main and hydrant system on the mine infrastructure terrace. Hose cabinets will be placed at the fire hydrant locations, supplemented with portable fire extinguishers placed within the facilities.

9.3.6.3 Potable Water

The containerised 6 m^3/h potable water treatment plant will be supplied from the raw water storage tank, and will comprise filtration, reverse osmosis, and the relevant chemical dosing. The treated water will be stored in an 80 m^3, above-ground potable water storage tank adjacent to the raw water storage tank. Potable water will be pumped to the following:

- Security Office and Change House Block
- Process Plant Administration Building
- Assay Laboratory

Details of the raw water quality analysis used by the vendor to select the water treatment plant are included in Annexure 9-7.

9.3.7 Plant Sewage Treatment

A 30 m^3/h modular sewage treatment plant will be provided on the mine infrastructure terrace for the treatment and disposal of the sewage generated. This is sized for a maximum capacity of 200 people, assuming 150 litres per day per person.

The technology selected is compact, simple and robust and uses a high efficiency combination of return-activated sludge plus submerged aeration media to purify effluent through various interlinked stages. This provides optimised nitrification and effluent quality to a standard that complies with the requirements of the DWAF for the release of treated effluent back into the environment, in accordance with the General Limit Values in terms of Section 39 of the National Water Act.

9.4 ACCESS ROADS WITHIN THE MINE LICENCE AREA

The road from the maintenance facility to the pit haul road will be designed as a mine haul road. As with other access roads, the mine haul roads will be topped with a 200 mm thick gravel wearing course.

The Tulu Kapi Gold Project includes the construction of roads that lie inside the mine licence area, specifically the following:

- Access road from Keley to the administration and mine maintenance facility: ~ 1 264 m
- Road from the administration and mine maintenance facility to the process plant: ~ 980 m
- Road from the mine maintenance facility to the pit: ~ 626 m

Two of these roads, shown in Figure 9-1, specifically the road to the process plant, and the road to the administration and mine maintenance facilities have been designed as an unpaved Design Class DS5 road for Mountainous Terrain in accordance with the Ethiopian Roads Authority's Design Manual for Low Volume Roads. The maximum road grade is 9 %. The roads include culverts where required for surface water management. When completed, the roads will be surfaced with a 250 mm thick crushed rock wearing surface.

All other roads, including the road from the mine maintenance facility to the pit will be designed as mine haul roads. These roads have been designed with a 25 m width that will support two-way mine haul truck traffic. The mine haul road design also includes 1 m high and 3.5 m wide safety berms made of either compacted soil or mine waste rock. The mine haul roads are typically constructed on a 1 m to 2 m foundation of mine waste rock. The design drawings for the roads within the Tulu Kapi mine licence boundary are included in Annexure 9-15.

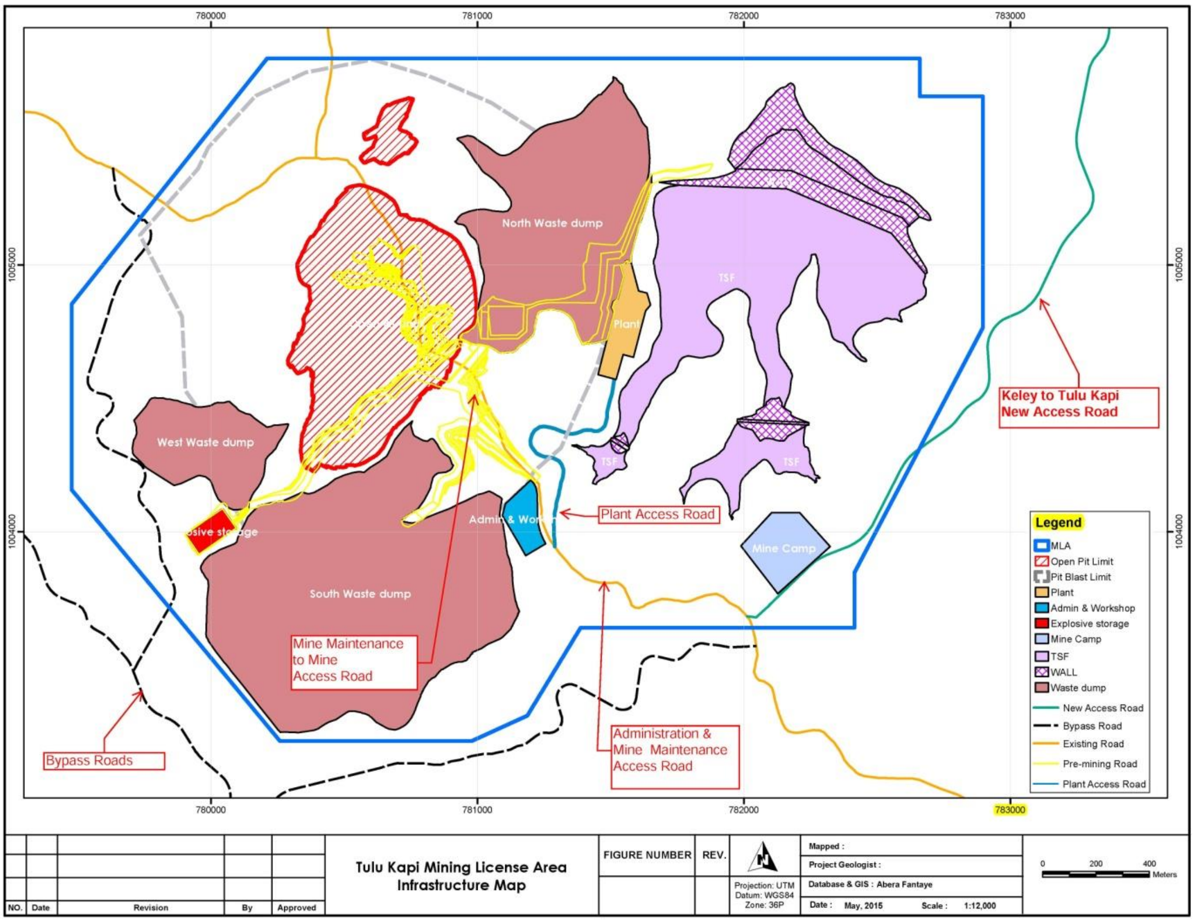

Figure 9-1: Roads inside the Mine Licence Area

9.4.1 Process Plant Access Road

The process plant access road follows the same traffic design template as the other access roads. This 980 m long road will have three culvert crossings to manage storm water at the locations shown in Table 9-1.

Table 9-1: Process Plant Road – Summary of Culvert Locations

Station	Structure Type	Flow Direction	Description
0+347	Pipe	Left	To divert ditch flow
0+645	Pipe	Left	To divert ditch flow
9+100	Pipe	Left	To divert ditch flow

9.4.2 Access Road from Keley Intersection to the Maintenance Facility

The access road from the Keley access road junction to the maintenance/administration facility follows the same traffic design template as the access roads. This road will have one culvert crossing to manage storm water at the location shown in Table 9-2.

Table 9-2: Access Road from Keley Intersection to Maintenance Facility – Culvert Location

Station	Structure Type	Flow Direction	Description
1+120	Pipe	Right	To divert ditch flow

9.4.3 Road from Maintenance Facility to the Pit Haul Road

The access road from the maintenance facility to the pit will be constructed to the standards of a mine haul road. As noted previously mine haul roads are designed with a 25 m width that will support two-way mine haul truck traffic. The mine haul road design also includes 1 m high and 3.5 m wide safety berms made of either compacted soil or mine waste rock. The mine haul roads are typically constructed on a 1 m to 2 m foundation of mine waste rock to provide a firm all-weather foundation for the mine trucks. Since this road intersects the access road to the explosives storage facility, it will also be used to transport explosives to the pit area. The mine haul road will be surfaced with a 300 mm thick crushed rock wearing surface.

9.4.4 Road to the Explosives Storage Facility

The access road to the explosives storage facility extends approximately 1 035 m from the facility to the intersection mine haul road leading from the maintenance facility to the pit. The explosives storage facility access road follows the same traffic design template as the other access roads within the mine licence boundary.

9.5 POWER SUPPLY

9.5.1 Introduction

As part of the development of the Tulu Kapi mining site, KEFI Minerals plans to have electricity supplied from the national Ethiopian grid. The mine will fund the infrastructure costs required to design, supply and construct a new 47 km, 132 kV, 15 MVA power line from Gimbi to the mine site. The power line will, however, be owned and maintained by the Ethiopian power authority known as the Ethiopian Electric Power Corporation (EEPCo).

Refer to Section 10, Project off-site infrastructure for details.

9.5.2 Grid Power

The grid power will be routed from Gimbi to and around the Tulu Kapi mining site at the following voltages:

- HV voltage: 132 kV
- MV voltage: 11 kV (site reticulation)
- Frequency: 50 Hz
- Power Factor: 0.85

EEPCo can supply 15 MW of power. The design, supply and construction of the power line will be a turnkey solution from EEPCo managed by the Client's representatives unless otherwise requested.

9.5.3 Supply Configuration – EEPCo

A supply configuration incorporating the following features is proposed:

- Extension of the 132 kV bus bar at Gimbi by means of a single circuit bay incorporating a line isolator, outdoor circuit breaker, and a line terminal structure
- Erection of 47 km of a 132 kV, single circuit line on galvanised steel towers
- Construction of on-site 132/11/6.6 kV substation
- Supply and erection within that substation of incoming 132 kV switchgear for two transformers
- Supply and erection within that substation of protection and metering equipment as specified by EEPCo
- Supply and erection within that substation of 2 × 15 MVA, 132/11 kV transformers

9.6 POWER DISTRIBUTION

9.6.1 Introduction

The Tulu Kapi mine will include various electrical infrastructure items required for operation. In addition to the process plant requirements, the electrical supply will be used for the following:

- Water abstraction
- Fuel storage
- Administration building
- Metallurgical building
- Medical building
- Storehouses
- Workshops
- Mine accommodation village

9.6.2 Electrical Reticulation

Power reticulation will be conducted at the following voltages as applicable to the application:

- Medium Voltage: 11 000 V AC
- Low Voltage: 400 V AC
- Control Voltage: 110 V AC

Table 9-3 provides a summary of the expected power requirements by area/equipment.

Table 9-3: Summary of Expected Power Requirements

Area or Equipment	Installed (kW)	Running (kW)	160 % (kW)	Maximum Start-up (kW)
Tailings return water, Raw water, Seepage Dam, Boreholes and Permanent Camp	285	205		205
Process plant infrastructure	266	190		190
Process plant	3 995	3 389		3 389
Mine infrastructure	589	410		410
Local community	1 000	800		800
SAG Mill (VSD controlled)	1 550	1 205	2 480	1 205
Ball Mill (LRS controlled)	2 800	2 607	4 480	4 480
Total	**9 598**	**8 806**		**10 679**

The maximum power demand for the project during mill start-up conditions is 10 679 kW, based on the following (worst case) equipment start-up sequence:

> **Process plant running + Process plant infrastructure running + Local community running + Mine infrastructure running + SAG mill running + Ball mill starting up**

The SAG mill will be started using a variable speed drive (VSD) and the ball mill will be started using a liquid resistance starter (LRS). The VSD will limit the SAG mill start-up current to 1.6 × full load current (frozen load protection) and the LRS will be designed to limit the ball mill start-up current to 1.6 × full load current.

Power factor correction equipment will be used to improve power quality and optimise the efficiency of the plant. The equipment required was established using the process plant equipment list to improve the power factor from 0.88 to 0.95.

9.6.3 Overhead Lines

Overhead lines will be used to provide power to the following off-site areas:

- Raw water dam
- Tailings dam
- Seepage dam

- Mine village
- Mine infrastructure terrace

The overhead lines will be designed and constructed generally in accordance with EEPCo code of practice.

The details of the overhead lines are as follows:

- Voltage: 11 kV
- Poles: Wooden
- Conductor: Gopher

Refer to Annexure 9-16 for the overall electrical reticulation drawings which show the overhead lines.

9.6.4 Electrical Equipment Specifications

9.6.4.1 Emergency Power Diesel Generators

The diesel generator specifications indicated in Table 9-4 were supplied by the vendor ZEST WEG Group.

Table 9-4: Diesel Generator Specifications

Description	ZEST Information
Engine Type	Volvo
Model	TWD 1643GE
Rated Prime kW	536 kW
Rated Standby kW	596 kW
Motor rpm	1500 rpm
High or Medium speed	High speed
Noise level	85 dB at 10 m
Alternator	Stamford
Model	HC 1534F1
Container solution	Yes
Container size	6 m (20 foot)
Power Factor	0.8
Output Voltage	400/230 V AC
Frequency	50 Hz
Insulation class	H
Fuel at 100 % of Full Load	126 L
Fuel at 75 % of Full Load	95 L
Fuel at 50 % of Full Load	63 L

9.6.4.2 Medium Voltage Switchgear

A common 11 kV containerised medium voltage substation has been allocated for the on-site and off-site mine infrastructure as identified in Annexure 9-17.

The switchgear will be rated using the following details:

- Medium voltage: 11 kV
- Frequency: 50 Hz
- Main bus bar rating: 1 250 A
- Basic insulation level: 95 kV
- Short circuit rating: 25 kA

9.6.4.3 Protective Relays

The protective relays supplied by the selected vendor are Square D Electrical Protection and Monitoring (SEPAM) digital relays, which comply with the American National Standards Institute (ANSI) standards.

Table 9-5 to
Table 9-8 outline the proposed protection relay requirements (using the ANSI standard device numbers) for the following:

- Grid and generator incomer (SEPAM S20)
- Bus section (SEPAM B21)
- Motor feeder (SEPAM M41)
- Transformer and overhead line feeders (SEPAM T20)

Table 9-5: Grid and Generator Incomer (SEPAM S20)

ANSI	Description	ANSI	Description
30	Annunciation	68	Logic discrimination
46	Negative sequence unbalance	79	Recloser (4 cycles)
50/51	Phase overcurrent	86	Latching acknowledgement
50G/51G	Sensitive earth fault	94/69	Circuit breaker contactor control
50N/51N	Earth fault		

Table 9-6: Bus Section (SEPAM B21)

ANSI	Description	ANSI	Description
27/27S	Undervoltage (L-L or L-N)	59N	Neutral displacement
27D	+ sequence undervoltage	81H	Overfrequency
27R	Remanent Undervoltage	81L	Underfrequency
30	Annunciation	86	Latching, acknowledgement

59	Overvoltage (L-L)	94/69	Circuit breaker contactor control

Table 9-7: Motor Feeder (SEPAM M41)

ANSI	Description	ANSI	Description
27/27S	Undervoltage (L-L or L-N)	46	Negative sequence unbalance
27D	+ sequence undervoltage	47	Negative sequence overvoltage
27R	Remanent undervoltage	48	Excessive starting time
30	Annunciation	49RMS	Thermal overload
32 P	Directional active overpower	50/51	Phase overcurrent
32Q/40	Directional reactive overpower	50BF	Breaker failure
37	Phase undercurrent	50G/51G	Sensitive earth fault
38/49T	Temperature monitoring	50N/51N	Earth fault
51LR	Locked rotor	68	Logic discrimination
59	Overvoltage (L-L or L-N)	81H	Overfrequency
59N	Neutral voltage displacement	81L	Underfrequency
60/60FL	CT/VT supervision	86	Latching, acknowledgement
66	Starts per hour	94/69	Circuit breaker contactor control
67N/67NC	Directional earth fault		

Table 9-8: Transformer and Overhead Line Feeders (SEPAM T20)

ANSI	Description	ANSI	Description
30	Annunciation	68	Logic discrimination
46	Negative sequence unbalance	26/63	Thermostat / Buchholz
50/51	Phase overcurrent	86	Latching acknowledgement
50G/51G	Sensitive earth fault	94/69	Circuit breaker contactor control
50N/51N	Earth fault	38/49T	Temperature monitoring

An assumed protection scheme was used for the sizing of all downstream equipment (from MV switchgear) to the motor.

Refer to Annexure 9-18 for the indoor medium voltage switchgear specifications.

9.6.4.4 Transformers

Distribution transformers will be manufactured in accordance with SANS 780, IEC 60076 and other relevant international standards, and will be

- Insulation medium oil insulated (ONAN)
- 3 phase
- 50 Hz Frequency
- Dyn11 Vector Group

Transformers will be designed using the following alarms and trips:

- Oil temperature alarm and trip
- Buchholz alarm and trip
- Pressure relief valve alarm and trip

Transformers that are smaller than 630 kVA will be of the completely sealed type. Transformers that are 630 kVA and greater will be of the free breathing type with an oil conservator with Buchholz, overtemperature, and pressure relief wired to an auxiliary terminal box.

Refer to Annexure 9-19 for distribution transformer specifications.

9.6.4.5 Low Voltage Distribution

The maximum transformer rating for low voltage supplies will be 2 000 kVA. Each transformer will feed a 400 V MCC that supplies power to a dedicated section of the plant. Feeds to MCCs will be single feeds only.

9.6.4.6 Motor Control Centres (MCCs)

Four containerised MCCs have been allocated for the process plant infrastructure.

MCCs shall comply with IEC 60439, shall carry the SABS stamp of approval.

MCCs shall have the following features:

- Be compartmentalised
- Be of the non-withdrawable type with moulded case circuit breakers
- Have magnetic contactors
- Have an earth bus
- Enclosures will be of the general-purpose type for indoor service (IP54) or of the weatherproof type for outdoor use (IP65), as required.
- Main buses will have a minimum current-carrying capacity of 400 A.
- Each MCC has a single 400 V/220/110 V AC control transformer rated for its specific control circuit requirements.
- The control circuit shall have UPS backup rated at 7.5 kVA in the event of a power failure
- Outgoing power and control wiring will be brought out to the terminals in the wireways.
- The equipment used will be Siemens with Simocode Pro V relay for efficient and reliable motor protection.

Refer to Annexure 9-20 for the MCC specifications, Annexure 9-21 to Annexure 9-24 for MCC single line diagrams, and Annexure 9-25 for MCC schematics.

9.6.4.7 Electric Cables

The details of the electric cables are as follows:

- All cables specified shall comply with the relevant part of SANS 1507.
- All outdoor cables shall be either buried in the ground or placed on cable racking.
- Cables shall cross underneath roads in dedicated PVC pipe sleeves.
- Grouped cables will be de-rated in accordance with SANS 10142-1 for 600/1 000 V cables.

9.6.4.8 Cable Racking

Cable racking will be used where cables are running on structures, indoors or where cable support is required and will include the following specifications for the various areas outlined:

- **General Areas:**
  - Hot dipped galvanised steel
  - Medium to heavy duty application
  - Welded construction
  - Standard straight length: 3 m
  - Side rail height: 76 mm
- **Cyanide-exposed area:**
  - Mild steel
  - Medium to heavy duty application
  - Welded construction
  - Standard straight length: 3 m
  - Side rail height: 76 mm
- **Acid-exposed area:**
  - 316 stainless steel
  - Medium to heavy duty application
  - Welded construction
  - Standard straight length: 3 m
  - Side rail height: 76 mm

9.6.4.9 Earthing

Provision has been made for earth resistivity testing prior to the installation of the earthing. Earth-mats will be installed in the following areas:

- MV substation
- Emergency power plant
- MCCs

The minimum earth wire size provided is 70 mm^2 between MCCs, substations and the power plant and the minimum earth resistance readings are shown in Table 9-9 below.

Table 9-9: Minimum Earth Resistance Readings

Areas	Reading
Plant wide	≤ 10 Ω
MV substation	≤ 5 Ω
Lightning protection	≤ 10 Ω

9.6.4.10 Lighting

Provision has been made for site area lighting and structure-mounted lighting to ensure safe working conditions. Lighting will also be installed to ensure that visual security monitoring can be conducted at all times in and around the process plant and associated infrastructure to maintain a safe environment.

Refer to Table 9-10 below for the minimum lux levels required in each area.

Table 9-10: Minimum Lux Levels

Area	Lux	Area	Lux
Electrical rooms	200	Stairs	25
Operating process floors	200	Supplementary area lighting	2
General process areas	200	Roads, yards and parking areas	5-10
Control room and offices	200	Safety and security areas	5-20
Maintenance areas/shops	200	General warehouse areas	150
General warehouse areas	150	Conveyors	50
Tunnels	100	General platform walkways	25

9.6.5 Process Plant Emergency Power Requirement

This section should be read in conjunction with the overall single line diagram in Annexure 9-17.

Emergency power of 1 260 kVA with an n + 1 redundancy has been allowed for in the DFS. This will allow critical process equipment to start up safely and continue to operate until grid power is reinstated. The emergency power requirements were determined by generating a list of equipment that must continue to run during a grid power failure or when the power is shut down for maintenance.

The emergency diesel power plant will be integrated into the 11 kV consumer substations via the following equipment:

- 3 × 400 V AC at 50 Hz rated at 630 kVA diesel generator sets
- 1 × 1 600 kVA, 400/11 000 V AC step-up transformer
- 3 to 4 day 23 000 m^3 diesel storage tank

Table 9-11 is a summary of the assumed process plant emergency installed and operating power by area for the sizing of the emergency power plant.

Table 9-11: Process Plant Emergency Installed and Operating Power

Equipment Description	Installed Power (kW)	Operating Power (kW)
Primary and Secondary Crushing Motor Control Centre (MCC)	246.5	128
Milling MCC	135.18	58
CIL and Detoxification MCC	367	335
Reagents MCC	69	60
Total	**818**	**581**

9.6.6 Mine Infrastructure Emergency Power Requirements

This section should be read in conjunction with the overall single line diagram in Annexure 9-17.

In addition to the process plant emergency power requirement, an additional stand-alone 630 kVA diesel generator will be located at the mine infrastructure terrace with the following equipment:

- 1 × 400 V AC at 50 Hz rated at 630 kVA diesel generator sets
- 3 to 4 day 14 000 m^3 diesel storage tank

When establishing the emergency power requirements for the mine infrastructure, it has been assumed that all facilities on the mine infrastructure terrace would remain energised during a grid power failure or when the power is shut down for maintenance.

Table 9-12 below provides a summary of the assumed mine infrastructure emergency and operating power requirements for the sizing of the emergency power plant. The explosives magazine emergency power requirement was excluded since it has been accounted for by using solar power.

Table 9-12: Mine Infrastructure Emergency and Operating Power

Infrastructure Building	Installed power (kW)	Operating power (kW)
Heavy Machinery Equipment workshop	150	98
Assay Laboratory	200	150
Clinic	37	24
Administration building	150	105
Gatehouse	5	3
Fuel Farm	37	24

9.7 CONTROL, INSTRUMENTATION AND COMMUNICATIONS

9.7.1 Control System

The Tulu Kapi mining project requires the implementation of a Process Control System (PCS), including instrumentation, a SCADA and programmable logic controller (PLC) system (using fibre optics as the backbone), an automation local area network (LAN) (utilising Ethernet and propriety control protocols), an office LAN, and a communication system (satellite, Internet, e-mail, telephone and radio). The PCS is necessary to monitor and control the process plant as well as to establish the infrastructure for the office LAN and telephone and radio communication systems.

The SCADA system consists of dual screen operator stations, two redundant I/O servers, one dual screen engineering station, a historian, and a webserver.

The purpose of the historian is to back up all the data for a pre-defined period and store it in a Structured Query Language (SQL) data format for extraction/interface with other systems Manufacturing Information System (MIS), Manufacturing Execution Systems (MES) or Enterprise Resource Planning (ERP), which are outside of the DFS scope.

The purpose of the webserver is to give controlled access to the real time screens and information of the control system, in a secure manner. Privileged information can therefore be accessed on the Internet in a secure and controlled manner, by only the persons with authorised viewing rights.

The system architecture is also based on a PLC system, with remote I/O stations situated in the plant. There will be two PLCs, the first to control the front end of the plant up to the ROM stockpile, and the second to control the rest of the plant. The front end and the rest of the plant can therefore be operated separately and will not influence one another if, for some reason, the one plant is without power. Mining operations and plant operations are separated by the ROM stockpile.

The control room and the PLC/control equipment room will be situated in the same containerised prefabricated room.

The PLC and SCADA system hardware will be housed in the PLC/control equipment room, which will normally be locked, or have limited access, and will also be climate controlled. Extension cables for the operator stations (dual screens, mouse, and keyboard) will be run from the PLC/control equipment room to the control room, as the computer CPUs will be kept in an environment that is secure and tamper free as well as climate controlled and dust free.

The PLC and SCADA software will be based on the piping and instrumentation diagrams (P&IDs), the control philosophy, and the functional specification. Standards will be used as much as possible to make factory acceptance testing (FAT) and site acceptance testing (SAT) as seamless as possible, and to ensure that future additions and deletions to software are carried out in a well-orchestrated manner.

Software licences for the PLC and SCADA system will be such as to enable future expansions if needed.

The PLC hardware will be designed to allow for a 20 % populated spare capacity, with an additional 20 % unequipped spare capacity.

The automation network will be based on an Ethernet topology, where the main backbone and the main nodes/switches will be of the fibre optic type.

The last piece of wiring will be a copper/CAT6 UTP cable.

9.7.2 Instrumentation

As part of the PCS, instrumentation has been allowed for to monitor and control the various functions of the process plant, as described in the control philosophy, the site layout and the P&IDs. The following valves and instrumentation have been allowed for in accordance with the P&IDs and control valve list:

- **Control Valves:**
  - Solenoid valves
  - Monitored hand valves
  - On/Off and modulating control valves
- **Instruments:**
  - Cyanide gas detectors

  - pH transmitters
  - Conveyor instrumentation, including
    - Belt pull-keys
    - Belt rip detectors
    - Belt alignment switches
    - Belt underspeed switches and blocked chute detectors
  - Densitometers
  - Flow meters and transmitters
  - Flow switches
  - Flow indicators
  - Level transmitters
  - Level switches
  - Pressure transmitters
  - Pressure switches
  - Pressure indicators
  - Temperature transmitters
  - Temperature switches
  - Temperature indicators
  - Weightometers

9.7.3 Office Network (LAN)/Communication System

9.7.3.1 Office Network

The office network (LAN) is required as the backbone to provide the following functionalities:

- Office computer traffic:
  - Daily operations
  - Daily e-mails
  - Internet (restricted as per IT policy)
- Local telephone calls – VOIP (restricted as per IT policy)
- Off-site telephone calls – VOIP (restricted as per IT policy)
- Security system – Operation/incident room, CCTV, access control, fire detection
- Connection to the satellite communication system
- Connection to the radio communication system

The office network (LAN) will be based on an Ethernet topology, consisting of 802.11 Wi-Fi and copper cabling. Provision has been made for expansion of the network infrastructure.

The cabling will be copper/CAT6 UTP cable, connecting each device (VOIP telephone, server other computers) to the office network. Notebook computers will also be able to connect to the Wi-Fi network.

The office network will consist of a satellite system to the mine administration office.

9.7.3.2 Telephone System

The telephone system will use VOIP (voice over Internet protocol) technology, using the office LAN as a backbone. Every network point will be of the integral type, which consists of an Ethernet connection point, as well as a telephone point. Telephone instruments have also been allowed for, and provision has been made for an area switchboard at the mine administration office.

The telephone system will fulfil all the local office communication needs, as well as provide restricted use of off-site communications via the satellite communication system.

The telephone system has been sized to handle 50 users locally, with 20 concurrent incoming/outgoing users (restricted by IT policy) using the satellite communication system.

9.7.3.3 Radio Communication System

The radio communication system will be used as an operations communication medium as well as an emergency/incident communication medium.

The following radio communications networks are proposed:

- Mining operations
- Plant operations
- Security operations
- Maintenance operations
- General communications
- Emergency communications

The radio communication system will consist of two base stations, one situated at the mine office, and one at the operations/incident room in the plant. A relay station will provide extended coverage to ensure that the communication networks retain maximum functionality at all times.

Vehicle-mounted and handheld radios have been allowed for and provision has been made for one base station to be connected to the telephone network. This will allow telephone network users to communicate with radio communication users on a one-to-one exclusive basis. This will happen in a controlled manner, through the operations/incident room radio operator, or as defined by the communications policy.

9.7.3.4 Satellite Communications

The Tulu Kapi mining project's satellite communication system will be implemented to ensure communication between the relevant role players involved from the construction phase through to the operational phase.

A data and communications link (through telephone, Internet and e-mail) is required between the new Tulu Kapi mine administration offices and the international users.

The personnel contingent will vary from phase to phase and therefore the system requirements will also vary from phase to phase. The system will be flexible enough to cater for these changes, causing the minimum disruption to implement such changes and having as low an impact on cost as possible. The system will also be flexible enough to be upgraded in the future, and to extend the bandwidth if so required.

The system will consist of the hardware required to enforce the IT policy for restricted Internet usage (on a time, bandwidth and access basis). Telephone connectivity will also be restricted by policy.

The existing satellite communication system will be used as far as possible. It will be located at the mine offices, where it will be connected to the office network, which will give the office network controlled access to the outside world via Internet, e-mails and telephone.

The satellite communication system will have a remote access functionality, which will be granted to the SLA contractor to perform remote maintenance on the system.

Temporary communication services will be located at the construction site offices. The internet breakout can be used at the construction camp as well as at the temporary site offices. The equipment used for this will become a permanent feature of the communications system.

9.8 TEMPORARY SITE OFFICES

The current exploration camp will be used for initial phase of project during the fabrication of construction camp and main camp.

9.9 CONSTRUCTION CAMP

A temporary construction camp has been allowed for to accommodate the construction team during the construction of the process plant. The camp has been designed to accommodate a total of 150 construction staff members. The breakdown of the accommodation units is as follows:

- 10 Management units (1 person per unit with en suite bathroom)
- 19 Junior management units (2 people per unit with shared bathroom)
- 17 Dormitory units for artisans (6 people per unit)

- Ablution facilities, including 3 communal shower and toilet units, and 2 toilet units
- 1 Managers Bar and Recreation Unit
- 1 Artisans Bar and Recreation Unit
- Mess Hall for Artisans (70 seater)
- Mess Hall for Management (50 seater)
- Kitchen and food store, including all kitchen equipment and furniture
- Laundry room including all equipment

The buildings will be modular prefabricated structures of “Chromadek” panel construction, which will be mounted on steel chassis and jacks. The modular structures do not require reinforced concrete foundations and are supported on a compacted terrace only.

The camp will include all sewage and potable water reticulation requirements including treatment facilities, as well as electrical reticulation and power supplied through a 315 kVA generator.

9.10 SECURITY

The process plant, village and explosives storage area will each be surrounded by a security fence to prevent unauthorised entry. Restricted access to these areas will be by means of a main access gate manned 24 hours per day by security guards. Provision for additional access emergency gates will be provided. These shall, however, be kept locked and strict access control procedures will be in place to control their use.

Additional fencing will be provided for safety and security within the following areas of the process plant area:

- Power plant (medium security fence)
- Fuel storage (medium security fence)
- Gold room area (high security fence)
- Transformers (medium security fence)
- Substations (medium security fence)

Gold will be transported by means of a secure vehicle to the helipad. Vehicles collecting gold enter into the fenced-off high security area. This area will be secured prior to vehicle entering the gold room via a roller-shutter high security door. Once the vehicle has entered the gold room, the roller-shutter door at the entrance will be closed, and the internal roller shutter door will be opened to allow loading of gold into the vehicle. Transportation of bullion to the helipad will be accompanied by security guards. Suitable security arrangements shall be in place.

Furthermore, the plant will be fitted with suitable CCTV cameras installed at strategic locations to provide monitored surveillance at the following locations:

- Gatehouse Weighbridge

- Security Building
- Main Admin Building and
- Gold Room
- Plant Perimeter

Static and pan tilt and zoom (PTZ) cameras, as well as monitors and control equipment, shall be provided as necessary, to allow for adequate security monitoring of the plant and gold room.

Views from the cameras will be fed to a central security control room situated in the security/access room of the plant and gold room security room.

9.11 FIREFIGHTING

The mine infrastructure terrace and process plant terrace are equipped with fire water systems as described in 9.2.8.2 and 9.3.6.2.

The fire water systems will incorporate buried fire water ring mains and hydrant systems. Hose cabinets will be placed at the fire hydrant locations and the systems supplemented with portable fire extinguishers.

A fire truck will be available on the mine site to attend to any grass or other fires not contained through the use of local fire extinguishers or in close proximity to installed fire water ring mains. The fire truck shall incorporate a water tank and on-board pumps, etc. to allow for remote stand-alone operations.

9.12 REFERENCES

IEC 60076, *Power Transformers.*

IEC 60439, *Low-voltage switchgear and control gear assemblies.*

SANS 780, *Distribution transformers.*

SANS 1507 (all parts), *Electric cables with extruded solid dielectric insulation for fixed installations (300/500 V to 1 900/3 300 V).*

SANS 10142-1, *The wiring of premises - Part 1: Low-voltage installations.*

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SECTION 10 Off-Site Infrastructure

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10.1 SUMMARY

The Tulu Kapi Project site is currently an undeveloped exploration site with an exploration camp and basic facilities to support the exploration carried out to date.

The project area is about 9 km south of the village of Keley, which is on the main Gimbi to Dembi Dollo road. The journey by road from Addis Ababa to Tulu Kapi covers a distance of about 520 km with the final 15 km by means of an all-weather unpaved road running through surrounding villages.

Regional population centres within easy road travel distance of the licence areas include Ayra, a small town about 20 km to the west of the project site, Gimbi, an important market town about 32 km to the east northeast, and Nekemte, a larger regional centre about 110 km to the east.

Chartered aircraft from Addis Ababa may land at an unregistered grass airstrip at Ayra - Gulliso, whilst Ethiopian Airlines operate scheduled flights three times a week to Assosa airport, a 4-hour drive from Tulu Kapi.

The closest point on the national power grid with the capacity necessary to supply power to the Tulu Kapi Mine is the Gimbi 132 kV substation, approximately 31 km, straight-line distance to the east of the site.

10.2 ROADS

10.2.1 Roads outside the Mine Licence Area

Although there is an existing road which connects the village of Keley to the project area, to minimise impact on the local community the Tulu Kapi Gold Project will require, during the project implementation period, the construction of two major roads that lie outside the mine licence area, specifically:

- Keley to Tulu Kapi access road. Total length of 14.97 km (~9.5 km lies outside the mine licence area).
- Southern Bypass road. Total length of 4.5 km.

The Keley to Tulu Kapi access road, shown in Figure 10-1, has been designed as an unpaved Design Class DS5 road for Mountainous Terrain in accordance with the Ethiopian Roads Authority's Design Manual for Low Volume Roads. The road will be 7 m wide and with a maximum road grade of 9 %. The Keley to Tulu Kapi access road will include culverts where required and a bridge constructed where it crosses the Birbir River. When completed, the Keley to Tulu Kapi access road will be surfaced with a 250 mm thick crushed rock wearing surface.

The government is currently upgrading the road between Genji and Keley and this road can serve as an alternative during the initial project implementation phase.

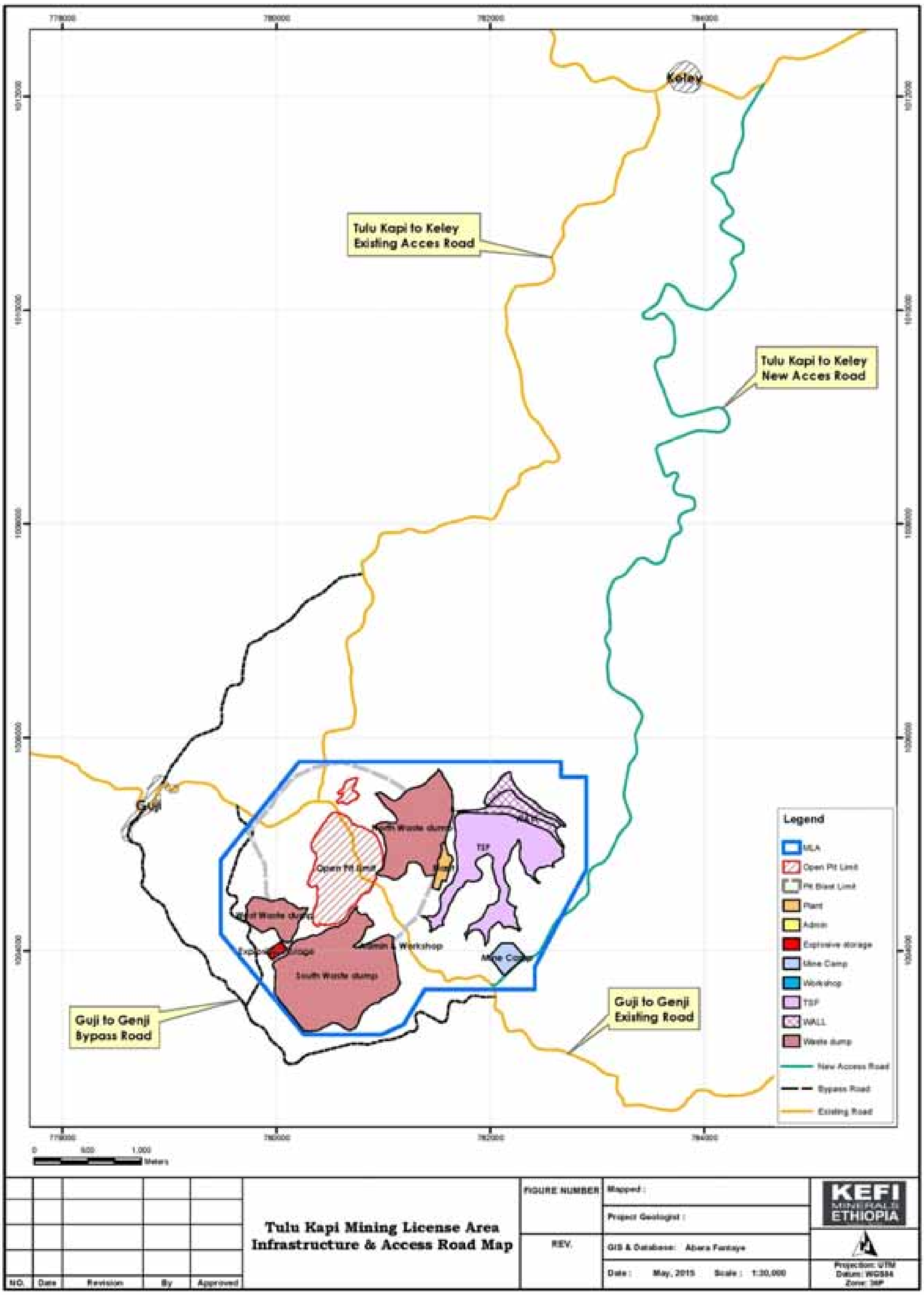

Figure 10-1: Roads Outside of the Mine Licence Area

The Southern Bypasses will be constructed to provide connectivity to the existing rural roads making best use of the topography to provide acceptable gradients and minimise disruption to the local community. The bypass roads will maintain existing traffic patterns and will be constructed as an unpaved, 3 m wide, Design Class DS9 road for Mountainous Terrain in accordance with the Ethiopian Roads Authority's Design Manual for Low Volume Roads. When completed, the road will be surfaced with a 150 mm thick crushed rock wearing surface.

10.2.1.1 Keley to Tulu Kapi Access Road

The Keley to Tulu Kapi Access Road will become the primary access road for the Tulu Kapi Gold Project. The road was planned to minimise impact on the local community and most of the road alignment follows existing tracks and footpaths. The road alignment was also planned to minimise the impact on agricultural crops and dwellings. The route survey will be updated during the detailed design to further optimise the route and impact on local community.

The road will incorporate 48 culverts to manage surface water at the locations noted in Table 10-1.

Table 10-1: Keley to Tulu Kapi Access Road – Summary of Culvert and Bridge Locations

Station	Structure Type	Description	Station	Structure Type	Description
0+140	Pipe	divert ditch flow	6+811	Pipe	divert ditch flow
0+510	Pipe	divert ditch flow	6+885	Slab	divert ditch flow
0+660	Pipe	divert ditch flow	6+979	Pipe	divert ditch flow
0+897	Pipe	divert ditch flow	7+357	Pipe	divert ditch flow
1+009	Pipe	divert ditch flow	7+472	Slab	divert ditch flow
1+296	Pipe	divert ditch flow	7+608	Pipe	divert ditch flow
1+410	Slab	divert ditch flow	8+189	Slab	divert ditch flow
1+623	Pipe	divert ditch flow	9+304	Pipe	divert ditch flow
2+089	Pipe	divert ditch flow	9+597	Pipe	divert ditch flow
2+320	Slab	divert ditch flow	9+910	Pipe	divert ditch flow
2+825	Pipe	divert ditch flow	10+375	Pipe	divert ditch flow
3+088	Pipe	divert ditch flow	10+918	Pipe	divert ditch flow
3+291	Pipe	divert ditch flow	11+155	Pipe	divert ditch flow
3+404	Bridge	River Crossing	11+591	Pipe	divert ditch flow
3+690	Pipe	divert ditch flow	12+011	Pipe	divert ditch flow
4+156	Slab	divert ditch flow	12+329	Pipe	divert ditch flow
4+393	Pipe	divert ditch flow	12+667	Pipe	divert ditch flow

Station	Structure Type	Description	Station	Structure Type	Description
4+985	Slab	divert ditch flow	13+035	Pipe	divert ditch flow
5+587	Pipe	divert ditch flow	13+842	Pipe	divert ditch flow
5+805	Pipe	divert ditch flow	14+704	Pipe	divert ditch flow
6+039	Pipe	divert ditch flow			
6+320	Pipe	divert ditch flow			
6+702	Pipe	divert ditch flow			

The Keley to Tulu Kapi access road ties into an existing road that is inside the mine licence area and ends at the town of Keley. Traffic on the Keley to Tulu Kapi access road will be able to drive to the Mine Accommodation Camp, Mine Maintenance facility, Administration Building, and Process Plant. The design drawings for the Keley to Tulu Kapi access road, based on the route survey carried by Golder Associates in 2012, are given in Annexure 10-1. A summary of the design and implementation schedule is given in Annexure 10-2.

10.2.1.2 Southern Bypass

The Southern Bypass was designed to divert public traffic, primarily from the village of Guji around the mine licence area. The Guji/Genji public road passes through the mine licence area and will be closed to the public when mining operations begin. The Southern Bypass will allow the public to safely divert around the mine licence area. The design drawings for the Southern Bypass are included in Annexure 10-3.

Six culvert crossings and two slab culvert crossings were included in the design to manage storm water at the locations shown in Table 10-2.

Table 10-2: Southern Bypass – Summary of Culvert and Bridge Locations

Station	Structure type	Flow direction	Description
0+640	pipe	Left	to divert ditch flow
1+114	pipe	Right	to divert ditch flow
1+850	pipe	Left	to divert ditch flow
2+820	pipe	Left	to divert ditch flow
3+370	pipe	Left	existing stream
3+840	pipe	Left	existing stream
4+100	pipe	Right	to divert ditch flow
4+280	pipe	Right	to divert ditch flow

10.2.1.3 Northwest Bypass

The 2.3 km Northwest Bypass is designed to divert public traffic around the mine licence area once mining operations initiate. The Northwest Bypass connects the existing north-south access road with the existing east-west Guji/Genji public road near the village of Guji and will follow existing tracks. Three culvert crossings were included in the design to manage storm water at the locations. The Northwest Bypass is designed to divert local traffic from the mining licence area and more specifically from the 500 m blast perimeter. The road will not be required during the initial project implementation phase and construction is planned one operations initiate. The design drawings for the Northern Bypass are given in Annexure 10-4.

10.2.2 Access Roads within the Mine Licence Area

The Tulu Kapi Gold Project includes the construction of roads that lie inside the mine licence area (see Figure 10-2), specifically the following:

- Keley access road to the administration and mine maintenance facility
- Administration and mine maintenance facility to the process plant
- Mine maintenance facility to the pit road
- Mine haul roads from the pit to the ROM stockpile, Mine Waste Dumps (MWDs) and Tailings Storage Facility

See Section 9 (Project Infrastructure) of this study for details.

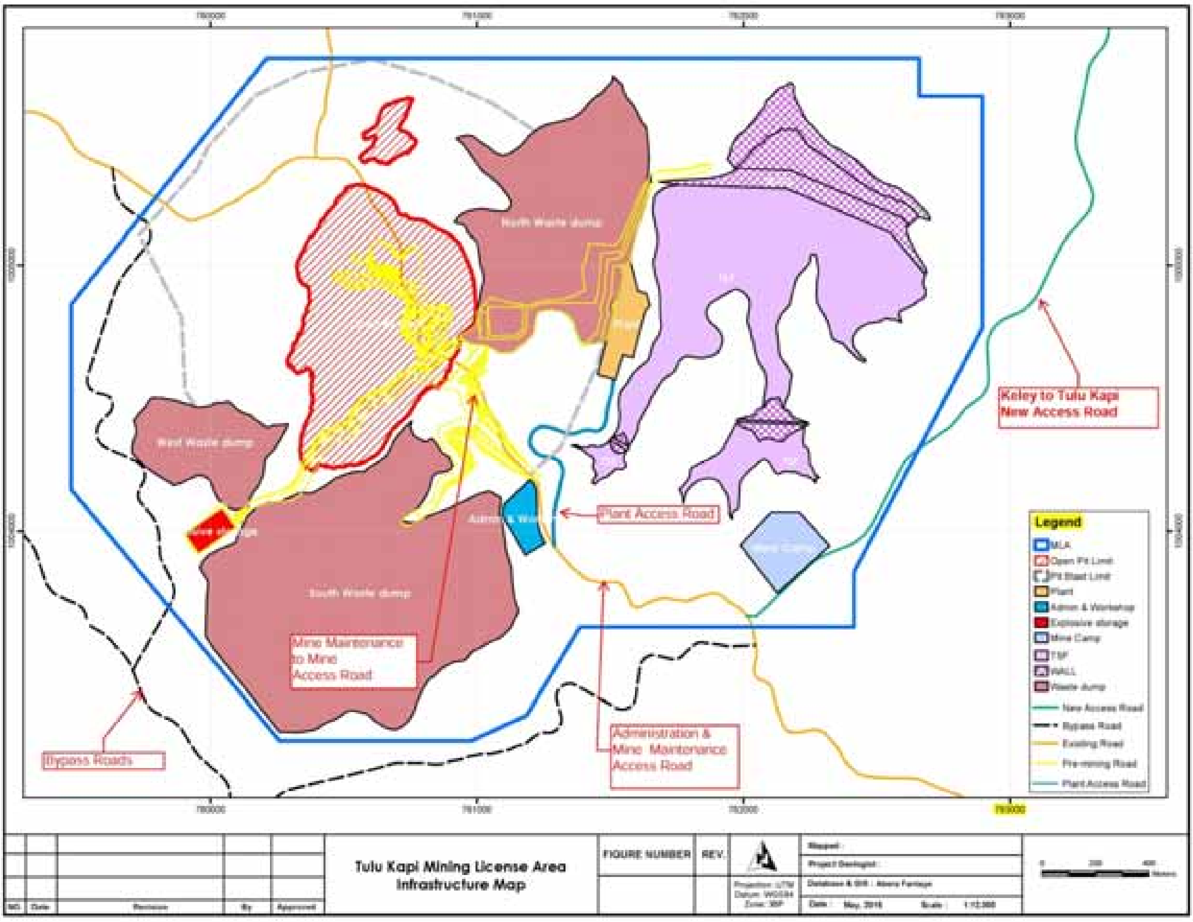

Figure 10-2: Roads inside of the mine licence area

10.3 GRID POWER SUPPLY

Detailed discussions have been held with the Ethiopian Electric Power Corporation (EEPCo) regarding the extension of the power supply from the EEPCo grid to the Tulu Kapi Mine site.

The advice of EEPCo is that there is sufficient capacity at their Gimbi 132 kV substation for such a connection to be made. The Gimbi substation is approximately 31 km straight-line distance from the Tulu Kapi site. For the 15 MVA supply capacity required over the distance involved between the two locations, 132 kV is also an appropriate supply voltage. EEPCo have, therefore, carried out a detailed survey, on behalf of KMP, to establish an optimum line route between Gimbi and the Tulu Kapi Mine site. The route chosen by them has been selected on the basis of access, topography and distance and covers a distance of 47 km. This is shown in Figure 10-3.

The full scope of the grid connection from Gimbi to the Tulu Kapi Mine will include the following:

- Extension of the existing 132 kV bus bar in the Gimbi Substation by a single bay
- Installation at Gimbi of 132 kV switchgear to control and protect the Tulu Kapi line
- Construction of approximately 47 km of 132 kV, 15 MVA minimum rated, transmission line on steel, lattice towers to connect Gimbi and Tulu Kapi
- Establishment at the Tulu Kapi Mine of a 132/11 kV substation incorporating 132 kV switchgear, a 20 MVA, 132/11 kV transformer, and appropriate metering and protection systems

The proposed connection, including the equipment at Gimbi and the Tulu Kapi Mine and also the interconnecting transmission line, would all be designed, specified and constructed to international standards, similar to other EEPCo infrastructure. It is based on establishing, from the beginning, a grid connection that can accommodate both the initial and possible future power requirements of the Tulu Kapi Mine.

Once the connection from the national grid to the Tulu Kapi Mine has been completed, tested and commissioned to the satisfaction of both KMP and EEPCo, its ownership will be handed over to EEPCo and it will become part of their infrastructure. This will include all of the installations within the Gimbi substation and the 132 kV transmission line to the Tulu Kapi Mine. In order to avail of the advantageous tariff prevailing for consumers taking supply at 132 kV, ownership of the 132/11 kV transformer in the Tulu Kapi Mine will remain with KMP. EEPCo has, however, indicated in discussions that they would be prepared to carry out routine servicing and inspections on that transformer on behalf of KMP under the overall service agreement that will apply to the Tulu Kapi Mine supply. The requirement for such work will be minimal.

As the grid connection for the Tulu Kapi Mine will become part of the EEPCo infrastructure, they will be entitled to use it for other purposes, to supply other consumers along its route or to serve as a link in their network to support other circuits. The conductor size (ASH) proposed for this connection is capable of carrying significantly more than the 15 MVA potentially required by the Tulu Kapi Mine. It is anticipated that this possibility will not have any negative consequences for the Tulu Kapi Mine. It could, in fact, be an advantage as the more consumers are reliant on the connection, the greater emphasis will be placed on EEPCo to ensure its integrity.

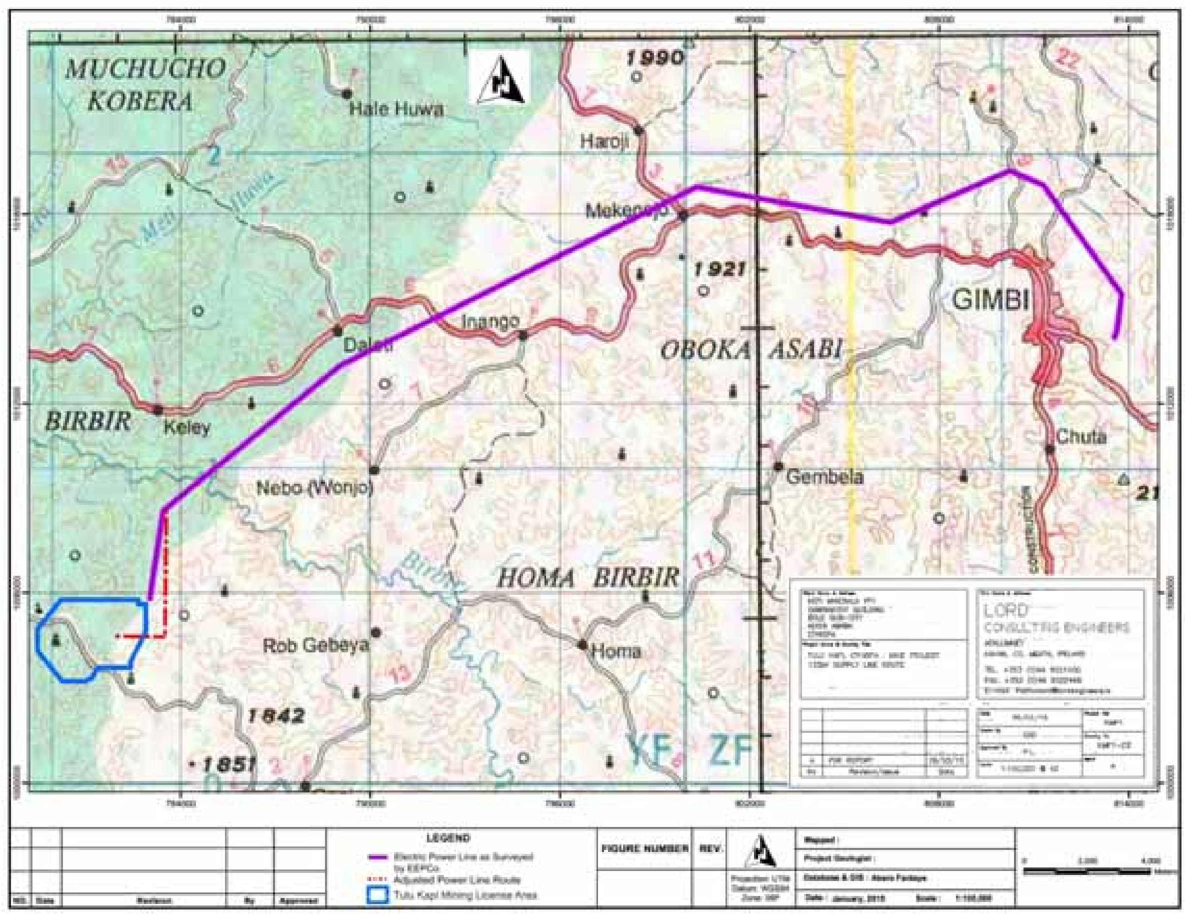

Figure 10-3: Power Line Survey Route

10.4 MINE ACCOMODATION CAMP

A mine accommodation camp will be constructed to house senior and junior staff members, comprising a combination of both expatriates and Ethiopian nationals who do not reside in the vicinity of the project site. The accommodation capacity of the camp will be for approximately 232 residents. Any additional camp visitors or contractors can be accommodated in the construction camp, which will remain on site following the project construction phase (additional capacity for 150 people).

10.4.1 Accommodation Categories

Staff accommodation will consist of Concrete Hollow Block (HCB) buildings with Galvanised Iron Steel roofing. Various categories of accommodation will be provided.

10.4.1.1 Senior Management

The senior management accommodation will cater for eight people. This category will consist of eight stand-alone buildings, consisting of a single bedroom, en-suite bathroom, lounge, kitchen, and dining area.

10.4.1.2 Supervisory Staff

The supervisor accommodation will cater for 96 people. This category will consist of the following two types of buildings:

- Type 2A - 6 buildings, consisting of 8 bedrooms each with basic bathroom en-suite
- Type 2B - 6 buildings, consisting of 8 bedrooms each with 4 basic external bathrooms

10.4.1.3 Artisans

The artisan accommodation will cater for 128 people. This category will consist of 8 dormitory buildings, consisting of 4 bedrooms in each. Dedicated, communal ablutions will be located centrally to service these dormitories.

10.4.2 Mine Camp Ancillary Buildings

Various other buildings will supplement the accommodation units, these buildings will contain the services required for the functioning of the camp. These buildings include the following:

- Gate House
- Village office
- Kitchen, dining and associated storage complex
- Recreational areas
- Laundry
- Convenience store

The conceptual design drawings for the general camp layout, dormitories and auxiliary buildings are given in Annexure 10-5.

10.4.3 Mine Camp Power

A dedicated 6.6 kV overhead line will run from the main incomer substation, in the vicinity of the mining workshop, to the camp. Power supply will generally be off the national grid; however during periods of power outage the emergency backup power plant will maintain power to the village.

A step-down transformer will be located at the village from which a domestic supply reticulation network will be established.

10.4.4 Mine Camp Water Treatment and Supply

A potable water treatment plant will be located at the mine camp. The accommodation potable water requirements will be pumped from the raw water dam in buried HDPE piping running alongside the relevant interconnecting roads.

A potable water reticulation network will provide water to the relevant buildings and facilities.

10.4.5 Mine Camp Sewerage and Sewage Treatment

A network of underground PVC piping will be installed for the collection and transport of sewage to the sewage treatment facility.

Biological treatment plant technology will be applied to the treatment and disposal of sewage in the camp. This technology will be selected over others due to its ability to withstand fluctuating loads.

10.4.6 Mine Camp Waste Management

The chosen waste management plan is for the collection and centralisation of all camp domestic waste.

Solid waste generated from the mine camp (including ancillary buildings) will primarily be domestic non-hazardous waste from the offices, kitchen and ancillary buildings (paper, refuse food, etc.). A comprehensive waste management plan will be developed for the project.

Solid domestic waste from the mine camp facilities will be recycled and re-used in an approved manner, where feasible. Other solid waste will be placed in waste receptacles and containers for disposal through waste collection contractors or suitable incinerator.

Construction debris and other inert waste will be placed in designated cells and covered, within the waste rock dump.

10.4.7 Mine Camp Access

Limited internal roads with sufficient parking will be established. A network of pedestrian walkways will be established throughout the camp interlinking all the relevant buildings and facilities.

10.4.8 Mine Camp Construction Execution Philosophy

The design and construction of the camp will be carried out by an Addis Ababa based project management company. The aim will be to maximise the use of Ethiopian expertise, labour, and material throughout the design and construction process. The design and implementation schedule is given in Annexure 10-2.

10.5 LOGISTICS AND TRANSPORT

10.5.1 Project Logistics Information

The construction logistics will be managed from SENET's head office to ensure a cost-effective process.

The following combination of global shipping methods will be applied:

- Method 1: Containerised cargo
- Method 2: Break-bulk cargo or charter vessels

10.5.1.1 Method 1: Containerised Cargo

Both 20 foot and 40 foot containers will be used to transport all cargo that can practically be fitted into containers and that meets with the maximum mass limitations thereof.

10.5.1.2 Method 2: Break-bulk Cargo / Charter Vessels

Heavy lift and out-of-gauge cargo that cannot be loaded into containers will be shipped on chartered vessels. Charter vessel rates are dependent on the following factors:

- Timing of shipment
- Vessel proximity
- Routing

Rates will be negotiated with the respective vessel owners from the port of exit up to Djibouti.

The shipping methodology is determined by the type of goods and equipment to be shipped, as outlined in the examples below:

- **Civil, Structural Steelwork and Plant Buildings**
  Due to the weight:volume ratio, the most cost-effective transport method would be with mechanicals that have a high volume ratio.

- **Piping and Valves**
  The most effective transport method would be break-bulk cargo or containerised cargo due to the volume constraints.
- **Mechanicals**
  The SAG and Ball mill will be transported in sections on a dedicated charter vessel to Djibouti and then to site.
- **General**
  The optimum shipment method for containerised cargo or abnormal shipments will be selected based on equipment specifics and timing to utilise break-bulk chartered vessels or container vessels.

10.5.2 Shipping Options

Table 10-3 provides a basic comparison of the shipping lines.

Table 10-3: Shipping Lines – Basic Comparison

Shipping Line	Trans-Shipment Port	Transit Time	Sailing Frequency
Pacific International Line	via Jebel Ali	32 days	Fortnightly
Messina Line	via Jeddah	25 days	Twice a Month
MSC	via Jebel Ali	37 days	Weekly
Ethiopian Shipping Line	via Jeddah	25 days	Fortnightly

10.5.3 Route

The recommended route to the Tulu Kapi site will be as follows:

- First leg: Durban to the Port of Djibouti by sea
- Second leg: Port of Djibouti to Addis Ababa by road
- Third leg: Addis Ababa to Tulu Kapi site by road

The Road Survey conducted in March 2012 indicated the following:

- Port of Djibouti to Addis Ababa: Road conditions are suitable for the movement of containerised and heavy lift cargo.
- Addis Ababa to Tulu Kapi Site: Delivery of containerised cargo and heavy lift cargo is subject to refurbishment or the repair of roads and reinforcement of several bridges. Major repairs and construction are currently underway.
- An official engineering study should be conducted before any heavy equipment is transported to site.

Major repairs and construction is currently underway by the Ethiopian government on the main highway from Addis Ababa to Gimbi and the Gedo to Nekemte road has been fully asphalted since the road route survey carried out in 2012.

Refer to Annexure 10-6 and Annexure 10-7 for the full road route survey details between the Port of Djibouti and the Tulu Kapi site.

10.5.4 Port of Djibouti

The Port of Djibouti is the major port, capital, and only city in the Republic of Djibouti on the northeastern coast of Africa. It lies on the south shores of the Gulf of Tadjoura off the Gulf of Aden.

Most of Ethiopia's imports are via Djibouti. Road and railway border crossings are through Galafi and Dewele for the eastern regions of Ethiopia. Under agreement between the governments of Djibouti and Ethiopia, an Ethiopian customs office is established at the Port of Djibouti. Following a specific request for each consignment, high priority cargo can be pre-cleared at Addis Ababa, with documents sent to the Ethiopian customs office at the Port of Djibouti for the release of the cargo.

Once Ethiopian customs have inspected the cargo at the Port of Djibouti, trucks can deliver direct to destinations without additional processing. Both Galafi and Dewele operate 24 hours a day and 7 days a week.

The dry port is located 2 km from the seaport and has a total area of 20 ha. The port has excellent nautical conditions; anchorage offers depths between 10 m and 40 m; and it is well sheltered by a coral reef.

The Marine Department in Djibouti Port works 24 hours a day. They also manage the dangerous goods and cargo, and guard against pollution.

Refer to Figure 10-4 and Figure 10-5 for aerial photographs of the Port of Djibouti.

Figure 10-4: Port of Djibouti - Overview

Figure 10-5: Port of Djibouti - Detail

The facilities at the Port of Djibouti are shown in Figure 10-6 below.

Figure 10-6: Djibouti Port Map

Table 10-4 provides map references to Figure 10-6.

Table 10-4: Map Reference with Dimensions

Map Reference Number and Description		Length (m)	Draught (m)
1 to 18	General Cargo	2 072	7 - 12
2, 13	Roll-on Roll-off (Ro/Ro)		11.5
21	Bulk Terminal	607	9.5 - 12

Table 10-5 provides key information about the Port of Djibouti.

Table 10-5: Port of Djibouti Information

Item	Description
Port Location	Djibouti
Port Name	Port of Djibouti
Port Authority	Port Autonome International de Djibouti
Address	BP 2107, Djibouti
Phone	253 35 23 31
Fax	253 35 61 87
e-mail	port@intnet.dj
Website	www.dpworld-djiboutiport.com
Latitude	11° 36' 7" N
Longitude	43° 8' 13" E
UN/LOCODE	DJ JIB
Port Type	Seaport
Port Size	Medium
International Ship and Port Facility Security Code (ISPS)	Security Level 1

Table 10-6 outlines the Port of Djibouti shipping details.

Table 10-6: Port of Djibouti Shipping Details

Port of Call Harbour characteristics, water depths, entrance restrictions, tug and pilotage requirements, lift and crane availability, supplies and services.			
General Information			
Latitude:	11° 36' 7" N	Publication:	172
Longitude:	43° 8' 13" E	Chart:	62095/3
First Port of Entry:	Yes	USA Representative:	Yes
Estimated Time of Arrival (ETA) Message Required:	Yes	Medical Facilities:	Yes
Harbour Characteristics			
Harbour Size:	Small	Harbour Type:	Open-Roadstead
Shelter:	Good	Turning Area:	Yes
Maximum Vessel Size:	Over 500 ft in length	Good Holding Ground:	Yes
Entrance Restrictions			
Tide:	Yes	Swell:	No
Ice:	No	Other:	Yes
Overhead Limit:	No		
Water Depth			
Channel:	31 ft – 35 ft (9.4 m – 10 m)	Anchorage:	21 ft – 25 ft (6.4 m – 7.6 m)

Cargo Pier:	21 ft – 25 ft (6.4 m - 7.6m)	Oil Terminal:	31 ft – 35 ft (9.4 m – 10 m)
Mean Tide:	2 ft		
Pilotage			
Compulsory :	Yes	Advisable:	Yes
Available:	Yes	Local Assist:	
Tugs			
Assist:	Yes	Salvage:	
Quarantine			
Pratique:	Yes	Ship Sanitation Certificate	Yes
Other:	Yes		
Communications			
Telephone:	Yes	Telegraph:	Yes
Radio:	Yes	Radio Tel:	Yes
Air:	Yes	Rail:	Yes
Loading and Unloading			
Wharves:	Yes	Anchor	Yes
Med Moor:	Yes	Beach:	
Ice:			
Lifts and Cranes			
+100 Ton Lifts:		Fixed Cranes:	
50-100 Ton Lifts:	Yes	Mobile Cranes:	Yes
25-49 Ton Lifts:	Yes	Floating Cranes	Yes
0-24 Ton Lifts:	Yes		
Port Services			
Longshore:	Yes	Electrical:	
Electrical Repair:	Yes	Navigation Equipment:	Yes
Steam:	No		
Supplies:			
Provisions:	Yes	Water:	Yes
Fuel Oil:	Yes	Diesel Oil:	Yes
Deck:	Yes	Engine:	Yes
Repairs, Dry dock, Railway and Other Services			
Ship Repairs:	Limited	Dry dock Size:	
Marine Railroad Size:	Small	Garbage Disposal:	Yes
Degauss:		Dirty Ballast:	No

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SECTION 11 Environmental and Social Impact Assessment (ESIA)

Tulu Kapi Gold Project
Definitive Feasibility Study

JULY 2015

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Scoping Studies | Prefeasibility Studies | Feasibility Studies | Engineering | Procurement and Logistics | Construction Management | Commissioning

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11.1 INTRODUCTION

11.1.1 Background to ESIA

KEFI Minerals Plc (KEFI) is required to demonstrate that the proposed Project's potential environmental and social impacts have been adequately considered, mitigated and managed. The Environmental and Social Impact Assessment (ESIA) has evaluated the baseline environmental and social conditions and determined the impacts of the proposed mine. On the basis of that information, an Environmental and Social Management Plan (ESMP) has been prepared that outlines mitigation measures to further minimise or eliminate negative social and environmental impacts. The basic guiding principles of the ESIA have been the following:

- To inform decision makers and result in appropriate levels of environmental protection and community well-being
- To provide timely information and outputs which assist with design and engineering modifications that reduce negative impacts
- To identify any significant environmental effects and key issues (i.e. the matters that must be taken into account when making decisions) and apply the necessary mitigation measures
- To provide opportunities to inform and involve the interested and affected parties, incorporating their inputs and concerns explicitly in the documentation and decision-making process
- To allow opportunities for participation by the authorities involved
- To ensure that the ESIA team has implemented appropriate methodologies and experts from the relevant disciplines (including local experts), and to ensure the team has assessed potential interrelationships between the bio-physical, social and economic issues
- To provide, as far as possible, an objective, rigorous and balanced assessment of the issues

11.1.2 Key Project Components

The proposed Project is a gold mine using an open pit mining method producing ore for processing from the open pits. Annual production is planned to be 1.2 million tonnes per annum (Mtpa). The life span of the existing identified resource base is 11 years; however, it is recognised that this may be extended depending on ongoing exploration activities.

The Project includes all activities and physical works associated with construction, operation, modification and decommissioning, including, but not limited to, the following key activities and components:

- Open-pit gold mine and associated waste rock dumps (north, west and south)
- Gold processing plant

- Tailings Storage Facility (TSF)
- Support facilities and infrastructure at the mine site, including water and waste infrastructure and storage facilities
- Accommodation and associated facilities
- Ancillary facilities and buildings, such as administrative offices, service buildings, laboratory, hydrocarbon storage, explosives storage
- Power line, haul roads and associated culverts

Key Project infrastructures are outlined in the following sections with a map of the proposed Tulu Kapi site infrastructure layout shown in Figure 11-1.

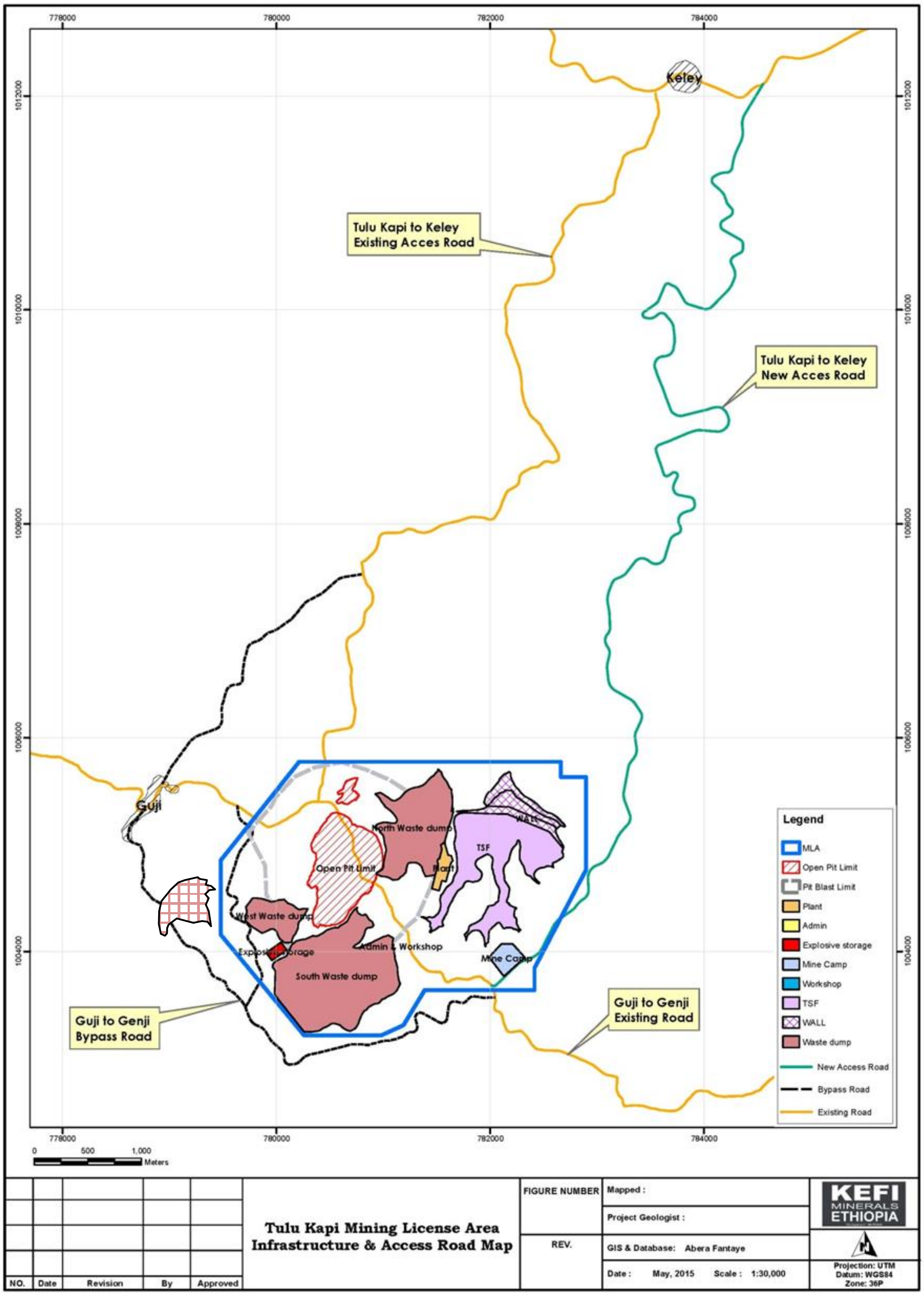


Figure 11-1: Proposed Site Layout

11.2 ESIA APPROACH

11.2.1 Regulatory Context

The ESIA study was carried out within the framework of Ethiopian environmental legislation and guidelines and in accordance with the requirements of the International Finance Corporation. The ESIA Process as applicable to development projects is detailed in the Environmental Impact Assessment Procedural. Guidelines Series 1' of November 2003. As per Schedule I of the guidelines, mining projects have the potential to generate significant environmental impacts, and therefore, require a full ESIA. In addition to the guidance note, the ESIA was conducted to ensure project compliance with the following:

- Ethiopian Regulatory requirements:
  - Mining Operations Proclamation No. 678/2010
  - The Environmental Protection Organization Establishment Proclamation No. 295/2002
  - Environmental Impact Assessment Guideline for Mineral and Petroleum Operation Projects, 2003
  - Directive No. 2/2008 on projects requiring an ESIA
  - The Investment Proclamation No. 37/1996
  - Solid Waste Management Proclamation No. 513/2007
  - Research and Conservation of Cultural Heritage Proclamation No. 209/2000
  - Environmental Pollution Control Proclamation No. 300/2002
  - Forestry Conservation, Development and Utilisation Proclamation No. 94/1994
  - Water Resources Utilisation Proclamation No. 92/1994
  - Water Resources Management Proclamation No. 197/2000 (*replaces 92/1994)
  - Payment of Compensation for Property Situated on Landholdings Expropriated for Public Purposes Council of Ministers Regulations No. 135/2007

- IFC Performance Standards:
  - Performance Standard 1: Assessment and Management of Environmental and Social Risks and Impacts
  - Performance Standard 2: Labour and Working Conditions
  - Performance Standard 3: Resource Efficiency and Pollution Prevention
  - Performance Standard 4: Community Health, Safety, and Security
  - Performance Standard 5: Land Acquisition and Involuntary Resettlement
  - Performance Standard 6: Biodiversity Management and Sustainable Management of Living Natural Resources
  - Performance Standard 7: Indigenous Peoples
  - Performance Standard 8: Cultural Heritage

11.2.2 ESIA Process

The ESIA Process for Tulu Kapi Gold was conducted through independent specialist assessment and stakeholder consultation in order to determine potential environmental, social, health and safety impacts from the Project, and to identify appropriate mitigation measures. The approach is outlined below in Figure 11-2.

Figure 11-2: ESIA Process for Tulu Kapi Gold Mine

Field specialist studies were conducted to describe baseline conditions of the Project area, including ecology, biodiversity, hydrology, ground water, air quality, soils, cultural heritage, socio-economics, noise, geochemistry and waste. Where applicable, field studies were undertaken so that data were collected to represent different seasons. During the Scoping

Phase, stakeholder consultation was undertaken with interested and affected parties (IAPs), and their issues and concerns were captured to be considered throughout the ESIA process.

On the basis of the baseline studies, a standard approach to impact assessment was applied to determine a wide range of impacts that can be clearly compared with one another. This incorporates two aspects for assessing the potential significance, occurrence and severity, which are further sub-divided as indicated. The impact ranking is described for both pre and post implementation of mitigation and management measures. The criteria to rank an impact are: Direction (positive, neutral or negative), Probability of occurrence, Duration, Magnitude, Scale/Geographic extent, Reversibility and Frequency. Environmental Consequence is defined as the overall residual consequence for each effect, and is classified as negligible, low, moderate or high by evaluation of the rankings for magnitude, geographic extent and duration. The risks and impacts were analysed for construction, operation and closure phases of the Project.

The findings of an ESIA were then translated into clear and measurable objectives to be achieved during construction, commissioning, operation and closure of the proposed Project. These objectives, and plans for their implementation, are captured in an ESMP.

11.2.3 Stakeholder Engagement

Concerns of key community stakeholders in the Project area were assessed, as well as relevant government stakeholders at Kebele, Woreda, Zone, and federal levels. The stakeholder groups consulted included affected community members; vulnerable groups; the agricultural office; the water, mines and energy office; the land and environmental protection office; and the Kebele and Woreda administrations. Perspectives and opinions of all consulted stakeholders were used to inform development and implementation of appropriate impacts mitigation measures, and have been incorporated into this report.

Primary concerns of community stakeholders are summarised as follows:

- Respect towards the community and preservation of community participation during project implementation
- Economic diversification
- Adequate and timely compensation for crop/livelihood loss
- Socio-economical and geographically appropriate resettlement of displaced households
- Availability of increased employment opportunities and skills training to local residents, with particular attention to gender equity and the youth
- Infrastructure improvements, particularly health services, all-weather roads, clean water, school facilities, and electrical supply

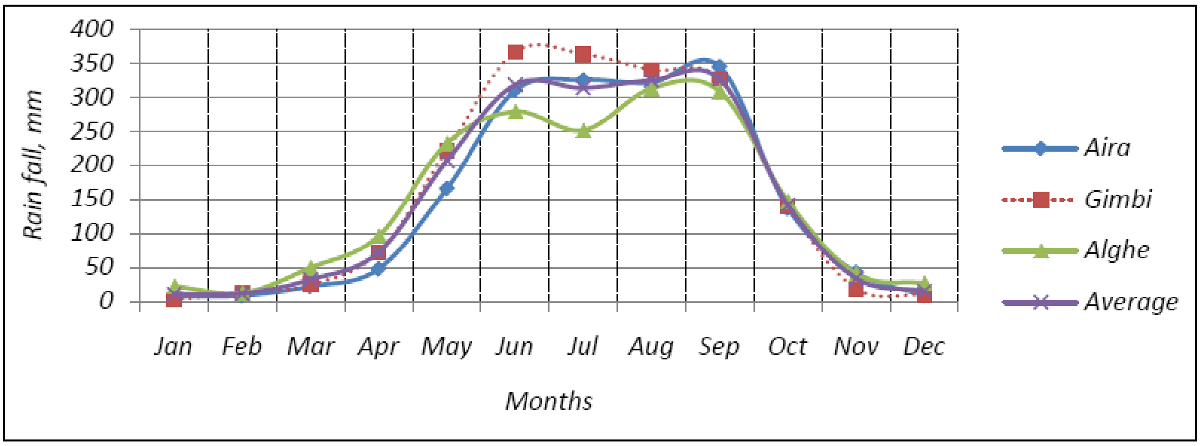
11.3 BASELINE ENVIRONMENT

The baseline environment as relevant to the Tulu Kapi Gold Mine Project can be summarised in the sections below.

11.3.1 Climate

11.3.1.1 Rainfall

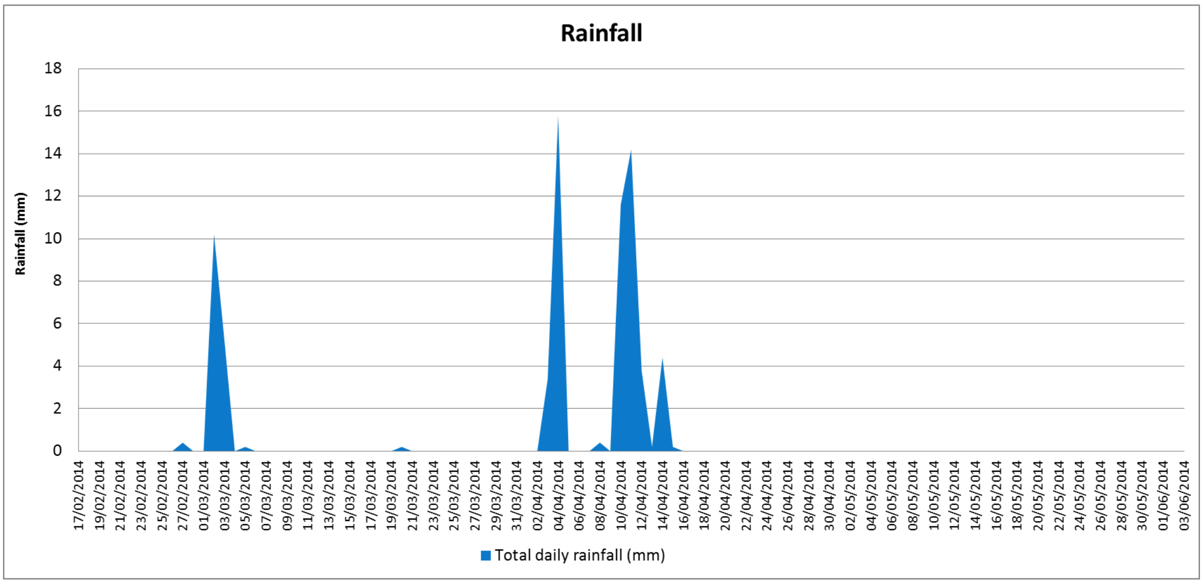
Figure 11-3 shows the mean monthly rainfall recorded across the region. Rainfall seasonality is evident with peak rainfall recorded between June and September. The mean total annual rainfall in the area is 1 805 mm.



Source: SRK Consulting, 2011

Figure 11-3: Mean Monthly Distribution of Rainfall from Aira, Gimbi and Alghe

On-site data from the Tulu Kapi Rotunda meteorological station for the period 17 February 2014 to 3 June 2014 recorded a total of 15.8 mm in March, 54 mm in April, and 0 mm in May (see Figure 11-4). March and April rainfall levels are consistent with the regional trends, however May 2014 received a lower rainfall than anticipated as rainfall is expected to increase significantly during this time (see Figure 11-3).

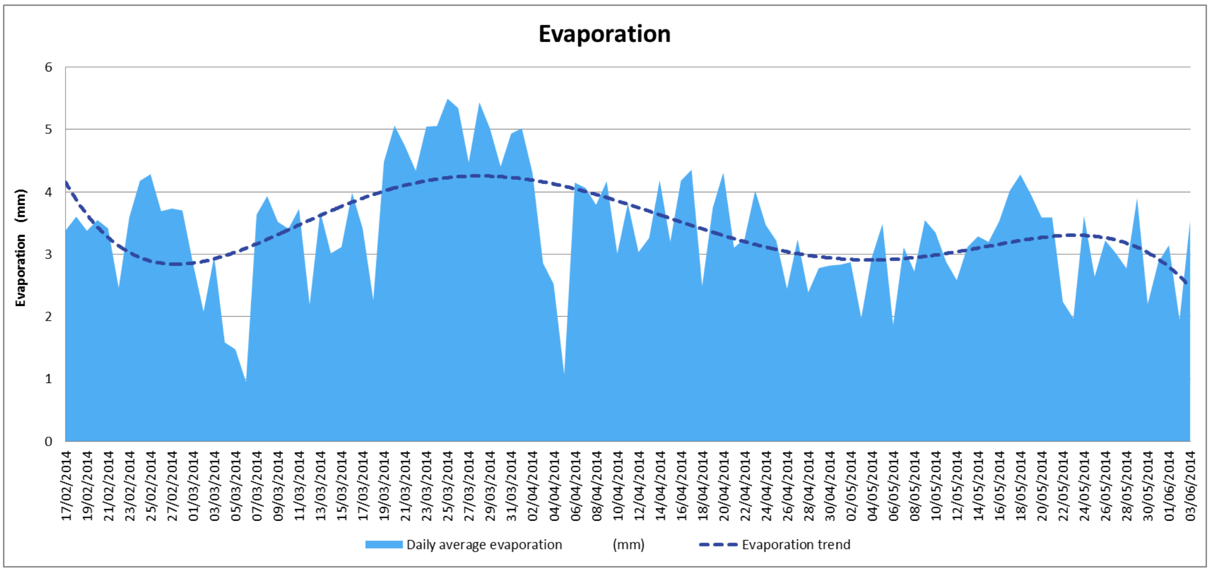


NOTE: Data recorded on site at the Tulu Kapi Rotunda meteorological station.

Figure 11-4: Rainfall Distribution from 17/02/2014 to 3/06/2014

11.3.1.2 Evaporation

Daily average evaporation recorded at the Tulu Kapi Rotunda between 17 February 2014 and 3 June 2014 ranged from a minimum of 0.9 mm to a maximum of 5.5 mm, with peak average evaporation for the period recorded in late March (see Figure 11-5).

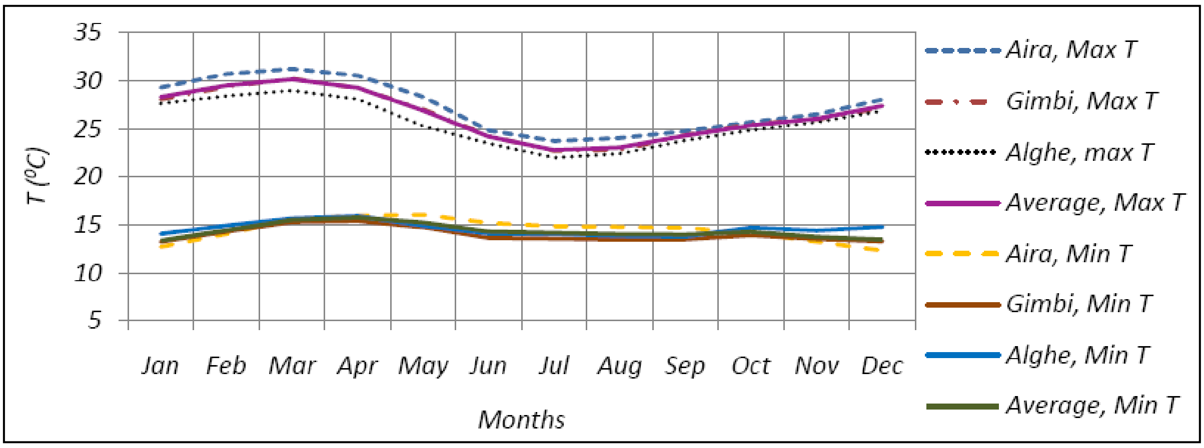


NOTE: Data recorded on site at the Tulu Kapi Rotunda meteorological station.

Figure 11-5: Average Daily Evaporation from 17/02/2014 to 3/06/2014

11.3.1.3 Temperature

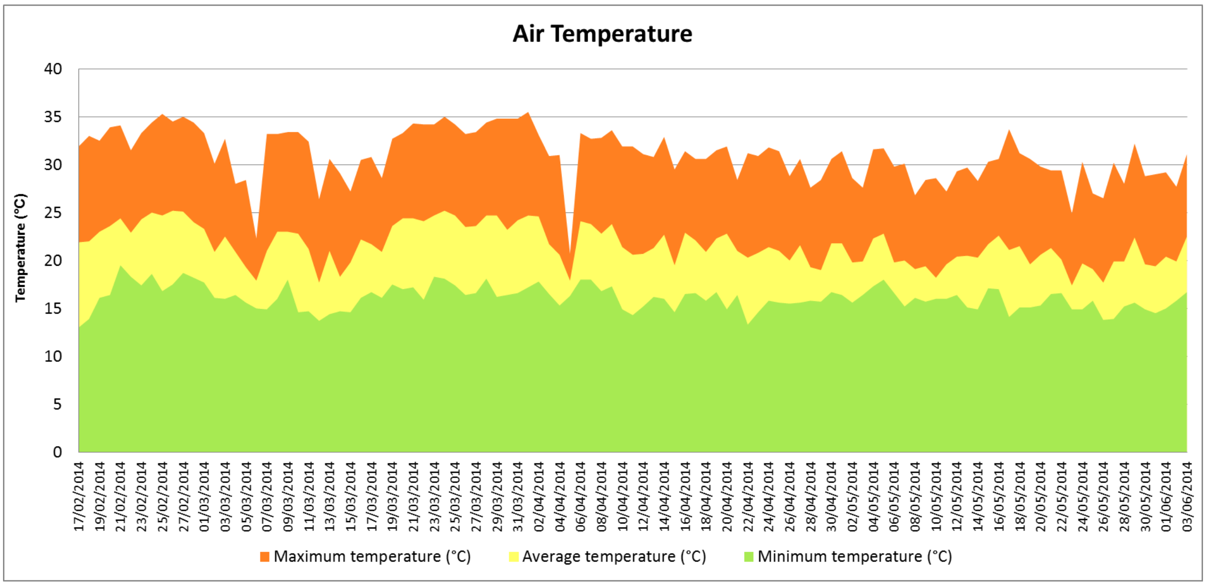
The trend in both maximum and minimum temperature observations is similar for the three regional stations (see Figure 11-6). The highest range between the average maximum and average minimum temperature is observed from January to February; whereas in July and August, the range is minimal. The highest temperature was reported in March (30.1 °C), and the lowest in the months of December to January (12.5 °C).



Source: SRK Consulting, 2011

Figure 11-6: Mean Monthly Minimum, Maximum and Average Temperature from Aira, Gimbi and Alghe

Average daily minimum, maximum and average temperatures recorded at the on-site Tulu Kapi Rotunda meteorological station for the period 17 February 2014 to 3 June 2014 are shown in Figure 11-7. Temperature ranges are consistent with the regional conditions, ranging from approximately 15 °C to 30 °C during this period. The maximum temperature (35.5 °C) was recorded on 1 April 2014.



NOTE: Data recorded on site at the Tulu Kapi Rotunda meteorological station.

Figure 11-7: Average Daily Minimum, Maximum and Average Temperature from 17/02/2014 to 3/06/2014

11.3.1.4 Wind Speed

The wind rose for Tulu Kapi was based on the analysis of the MM5 modelled meteorological for the years 2007 to 2011 (see Figure 11-8). Winds at Tulu Kapi are expected to originate from the south-south-west (9.25 % of the time) and south (7.75 % of the time). Wind speeds are low, with a high percentage (18.5 %) of calm conditions (< 1 m/s).

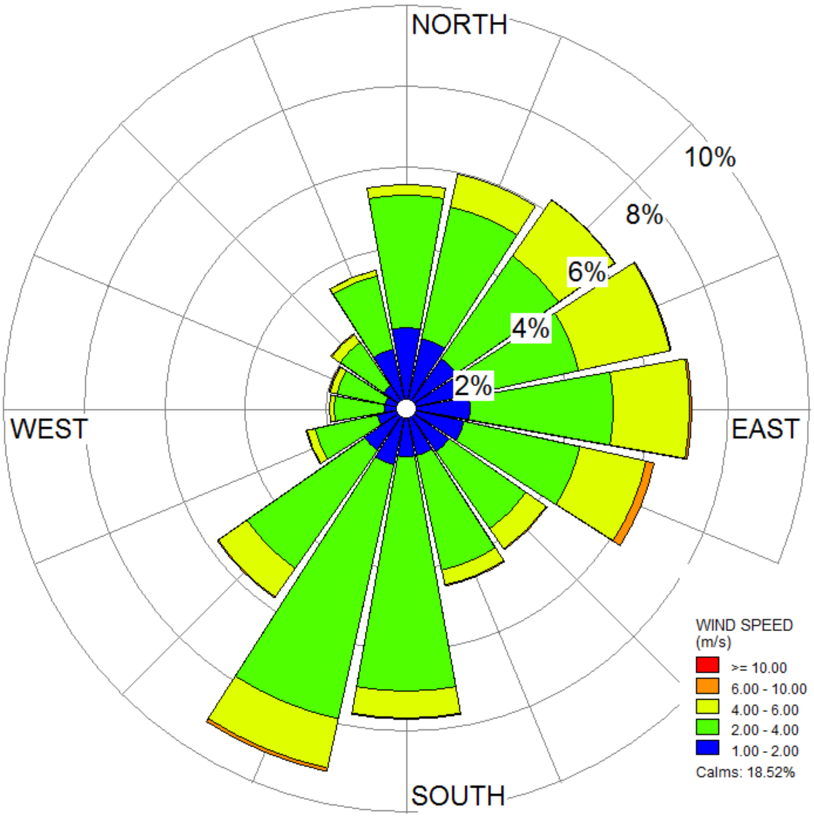


Figure 11-8: Modelled Wind Rose and Wind Frequency Distribution for the Tulu Kapi Site for the Period 2007 to 2011

11.3.1.4.1 Diurnal

Between 00:00 to 05:59, winds are predominantly from the south (14 % of the time) and south-southwest (10 % of the time). During the morning (06:00 to 11:59), winds originate from the east-southeast (12.1 % of the time) and east (11.9 % of the time). During the afternoon and early evening (12:00 to 17:59), winds originate from the north (13.5% of the time) and north-northeast (12 % of the time). During the late evening (18:00 to 23:59), winds largely originate from the south-southwest (13.5 % of the time) and north-northeast (9.5 % of the time).

11.3.1.4.2 Seasonal

During winter (DJF), winds are predominantly from the east-north-east (15 % of the time) and east (14 % of the time). During spring (MAM), winds are predominantly from the south (10.5 % of the time) and south-southeast (8.5 % of the time). During summer (JJA), winds are predominantly from the south-southwest (21 % of the time) and southwest (15 % of the time). During autumn (SON), winds are predominantly from the north-northeast (9 % of the time) and equally east and northeast (8 % of the time).

11.3.2 Geology

11.3.2.1 Regional Geology

The region lies within the Arabian-Nubian Shield which consists of Upper Proterozoic rocks (up to 800 Ma) and is best described as a granite-greenstone terrain. Additional weakly metamorphosed volcano-sedimentary successions of late Proterozoic age (more than 570 Ma) occur within the terrain.

The western Ethiopian Shield, in which the Tulu-Kapi deposit is found lies in the volcano sedimentary sequence dominated by up to 70 % of meta-intrusive rocks, ranging from granite to diorite to gabbro in compositions. Most of the gold indications in western Ethiopia are hosted in sheared meta-intrusive rocks.

A major north-northeast oriented shear passes through the Tulu Kapi area and tracks north for more than 100 km where it horsetails to form a series of smaller shears, the majority of which host gold shows previously recorded by the UNDP in the 1970s.

11.3.2.2 Local Geology

The geology associated with Tulu Kapi consists of rocks ranging from Precambrian to Tertiary in age. The Precambrian rocks consist of gneisses, low-grade volcano-sedimentary rocks with associated mafic to ultramafic intrusions and meta-intrusive rocks.

The following identifiable rock units are diagnostic of the area of the Tulu Kapi deposit (oldest to youngest):

- Basement granitic gneiss
- Meta-sedimentary units
- Birbir Group basement rock
- Quartzites
- Ultramafics
- Mafics and intruded metagabros, metadiorites
- Meta granites
- Syenites

11.3.3 Geohydrology

As the site is located on a hilltop, a surface water and groundwater divide is present. The small springs occur where the topography intersects the water table in the valleys. There is a high degree of weathering of the basement at the site, and this has led to the formation of saprolite (rock weathered to an unconsolidated state), which constitutes a shallow aquifer. This is distinct from the deeper aquifer, which occurs in fractures at considerable depth.

The details of bores drilled suggested the following hydro stratigraphic profile:

- Saprolite (up to 22 m thickness) – degree of saturation unknown
- Weathered rock – up to 6 m thick
- Water-bearing fractures in bedrock encountered at 79 m and 86 m depth, with static water levels of 8 m to 25 m below ground level

Examination of cores concluded that the material has relatively high porosity, and therefore would have relatively high storage and relatively high hydraulic conductivity. The fractured bedrock aquifer produced a transmissivity value of 0.9 m^2/d (based on an aquifer thickness of 30 m and a hydraulic conductivity of 0.03 m/d). These values indicate poor aquifer potential in the fractured bedrock. The degree of connection between the saprolite aquifer and the bedrock aquifer was not established.

11.3.4 Geochemistry

Based on static tests of humidity cell samples, the geochemistry of the Project area can be characterised as the following:

- Particle size distribution analyses indicated that the bulk of the materials in the humidity cells occurred as gravel followed by sand and silt-sized particles.
- Mineralogical analyses indicated that pyrite was the dominant sulphide mineral both before and after kinetic testing. Minerals with a high to moderate neutralisation potential included calcite, ankerite, lizardite and chlorite. The most abundant mineral was albite, which generally has a low neutralisation potential. There were generally slight depletions in most minerals, with quartz and chlorite occasionally showing higher proportions in sample before than after kinetic testing, indicating heterogeneity in the samples. The percentage of quartz may also have gone up due to constant sum problem.
- Total elemental analyses indicated that Ag, As, Ba, Cd, K, Mn, Mo, Na, Pb, S, Sb, W, and Zn are enriched in the rock units at Tula Kapi. These elements could be leached out of mine facilities when minerals weather. The elements, except for Mo and W, are potentially toxic to humans and are therefore Constituents of Interest (COI).
- The paste pH of both the low grade ore and waste rock materials was alkaline (pH=8.2-8.5) indicating availability of excess Neutralisation Potential (NP).
- The total sulphur content of the materials ranged between 1.3 % and 2.2 %, the bulk of this was sulphide sulphur (1.1 %-1.8 %). Low values of both total and sulphide sulphur were recorded in the waste rock sample representing average sulphur content in albitised syenite. The highest sulphur content was recorded in the low grade ore sample;
- All the tested materials classified as Potentially Acid Generating (PAG).
- The Carbonate Neutralising Potential (CaNP) was significantly higher than Bulk NP indicating that a significant portion of the inorganic carbon was not generating alkalinity.

The main findings from the kinetic tests are as follows:

- The leachate from all the humidity cells was observed to be circumneutral (pH= 6.2-7.1) for the duration of the testing period.
- Major cation (Ca, Mg, Fe, Mn, Al and Si), trace metal (e.g. As, Cd, Cu, Ni, Pb and Zn) and sulphate (SO_4^{2-}) release rates were generally low or decreased to low levels after a few cycles of testing under neutral pH conditions. Except for Cd, Co, Cu Ni and Zn that were occasionally detected, all the other trace elements remained below detection limit throughout the testing period.
- Though SO_4 and metal release rates were generally low, exceedances of water quality guidelines were noted occasionally for alkalinity, SO_4^{2-}, pH, Ca, Fe, K, Mn and Ni. These metals and SO_4^{2-} are likely to be leached from the waste rock and low grade ore stockpiles under circumneutral pH conditions. Arsenic (As), Cd, and Pb, which are also potential COI, was quantified at the analytical method detection limit, which was equal to or higher than the water quality guidelines for the elements.
- The tested materials revealed a low degree of sulphide reactivity despite the relatively high sulphide content (> 1 %). The sulphides contained in the humidity cell samples do not oxidise rapidly and release very low levels of acidity throughout the testing period. The low reactivity of the sulphides indicates that low rates of acid loadings will be released from the albitised syenite waste rock and low grade ore materials. This need confirmation by site specific data, which can be obtained from in-field kinetic tests and wall washing during the operational phase of the Project.
- The observed low sulphide reactivity could be related to the grain size (< 0.1 mm to 10 mm) and texture (euhedral to subhedral) of sulphide grains and geochemical processes in the humidity cells, including precipitation of secondary iron hydroxides (e.g. ferrihydrite), which result in armouring of pyrite grains, hence reduced oxidation rates.
- The CaNP rate was consistently higher than acid potential (AP) rate throughout the testing period indicating the slow reactivity of sulphides and availability of dissolving and fast reacting carbonates and silicates. Thus, albitised syenite and low grade ore are not potentially acid generating (Non-PAG) in the short to medium term, as indicated by paste pH. However, the carbonate molar ratio indicated insufficient carbonates to buffer acidity in the long term. This was confirmed by time to depletion projections, which indicated that carbonates will be depleted much earlier than sulphides. Therefore the low grade ore and albitised syenite waste rock materials could be PAG in the long term.
- The release rates of Al, K, Na and Si indicated that silicates are potential long term sources of NP in the waste rock and low grade ore. However, silicates generally weather at a slower rate than pyrite. As a result, the low grade ore and albitised syenite waste rock units could be PAG in the long term. Site-specific rates are required to confirm time for NP depletion and oxidation rates.

11.3.5 Hydrology

Ethiopia is divided into 12 main river basins, and the mine is situated in the most westerly of these, the Baro-Akobo basin. The Baro-Akobo basin is 76 000 km^2 in area, and forms the headwaters of the West Nile, which flows from Ethiopia to Sudan, and ultimately discharges to the Mediterranean. The Birbir River dominates the region around Tulu Kapi, and flows westwards, then southwards, about 8 km from the mine site.

Stream gauging was conducted manually weekly over all seasons to evaluate baseline flows in watercourse with and downstream from the Project area. In addition, hydrocensus baseline data was collected for major rivers and streams in the area to identify the major water uses downstream of the envisaged gold mining and tailings dam area, the results of which are documented in baseline data.

11.3.5.1 Surface Water Quality

Both perennial and ephemeral streams occur within the Project area and water quality sampling was completed over all seasons as part of the baseline program. Note that additional water samples were also taken in 2015 of streams situated within and downstream of the proposed South Waste Rock Dump (WRD). The objective of the water quality assessment (water sampling and analysis) was documentation of baseline conditions. Every 3-4 months over all seasons, 17 samples were collected from different sources for on-site analysis of different parameters. The on-site analysed parameters were pH, TDS, EC, turbidity, faucal coliform and total coliforms. Sources include boreholes, springs and water points (faucets) at the mining exploration camp. In addition to the on-site analysed parameters, 13 water samples (same sources as above) were collected, preserved and transported to the EPA laboratory in Addis Ababa for heavy metal and other physio-chemical parameters analysis.

Samples from protected water sources showed zero faecal coliform; however, water samples from unprotected community springs typically have high faecal coliform concentrations. The results show that while coliforms are prevalent in all the water sources sampled, faecal coliforms appear to be limited to the springs, not all of which are protected from access by livestock. Local health authorities were advised of test results and to take appropriate measure such as boiling water or using chlorine purification products before drinking the water.

For some parameters, such as pH, EC, nitrate and chloride, results analysis comparisons have been completed four times (samples throughout all seasons). Most show similar trends of variation for different sources though there are some irregularities.

The results of laboratory analysis for physicochemical parameters and heavy metals have been compared with the WHO standards for potable water quality and the Ethiopian national drinking water guidelines. Higher iron and chromium concentration have been noted for many water sources. Water quality monitoring results reveal that water is fresh (EC (electrical conductivity) values (40 – 90 uS/cm) and the overall level of minerals are low) and that it is slightly acidic. Low nitrate and chloride values reflect a low intensity of agricultural use.

11.3.5.2 Soils

Physiography of the Project area can be characterised as highly dissected and hilly terrain with slopes ranging from very steep to almost flat. It can generally be categorised into the following three physiographic units:

- A sharply crested, highly dissected mountainous and hilly area with slopes ranging from very steep to almost flat and high internal relief
- An undulating to rolling area with slopes ranging from moderately steep to almost flat and a high internal relief
- Valley bottoms which are flat, and a long narrow terrain of fluvial origin. The valley bottoms are located between the dissected terrains of the above physiographic units. The soils of the valley bottoms are fluvisols developed from alluvial deposits. They are poorly drained and they restrict rooting because of a raised water table.

The textural class of the studied soils varied from sandy clay loam or sandy loam in the surface to sandy clay loam to clayey in the subsoil horizons. The content of clay varies from 17 % in topsoil horizon to 51 % in subsoil horizon. This reveals an increasing pattern of clay and a decreasing pattern in sand and silt contents with depth of most profiles. Hence it is possible to identify most subsoil horizons as argillic (Bt) horizons. In most of the profiles subsoil horizons had more or less uniform clay distributions.

11.3.6 Land Cover

The land cover and land use pattern and distribution in the study area are as given in Table 11-1.

Table 11-1: Land Cover and Land Use Pattern and Distribution in the Project Area

Sr.No.	Land Use / Land Cover Type	Area in ha	% of total
1	Cultivated land	371.3	53.1
2	Forest (Coffee + Plantation)	218.3	31.2
3	Bush land (Grazing)	87.5	12.5
4	Tenant house	6.3	0.9
5	Degraded land	6.1	0.9
6	Vegetation	5.3	0.8
7	Tenant house_2	2.9	0.4
8	Tulu Kapi Camp	1.4	0.2
	Total	**699.1**	**100**

11.3.7 Biodiversity

11.3.7.1 Flora

The assessment study showed the occurrence of four vegetation and land cover types in the Project area and its surroundings. None of the vegetation types has been found to be natural vegetation. Although the forest patches in the valleys and adjacent lower parts of hillsides have good tree cover, these forest patches have experienced severe biodiversity degradation due to the clearing of the seedlings and saplings of woody plants and all the herbaceous plants to avoid or reduce competition with the managed coffee plantation. Nevertheless, the disturbed forest patches and the other areas, outside the cultivated areas have been found to be rich in plant biodiversity harbouring about 246 vascular plant taxa, of which nine are endemic to Ethiopia. Only one of these endemic taxa has been assessed fulfilling the threat category Vulnerable (VU).

The transformed landscape has also been found planted with a number of food and non-food plants, while about thirty medicinal plants have also been reported from the area. The assessment study revealed that, so far, the Project area and its surrounding areas are free from invasive alien species. However, it was noted that future activities of the Project, including road construction, may result in the introduction of invasive alien species that have infested other parts of Ethiopia.

11.3.7.2 Fauna

A total of 64 species of birds belonging to 30 families were recorded, out of which 4 were endemic. From the conservation point of view, all are of least concern (LC) according to IUNCN red list (IUCN 2007). Among the biome assemblage species, 10 Afrotropical Highland Biome (HB) species were recorded from the area. There are 48 HB species in Ethiopia, and the site holds only 20 % of that.

Since it is predominantly agricultural land and settlement, the area is very poor in mammal species diversity. Only few cosmopolitan species were seen and/or indicated to occur in the area by the local informants. Of the seven species found in the area, three are considered as near-threatened, according to the IUCN threat category, and four are of low concern. All the species falling within NT category are pests and damage crops or livestock. Hence, all the species are of less conservation value.

The area is drained by several small streams, which eventually join the Birbir River, which in turn is the major tributary of the Baro River. Although not within the Project Area, the rivers in the Baro-Akobo basin are rich in fish diversity (Nilo-Sudanic).

11.3.8 Noise

The Project area is characterised by a combination of sparsely populated farmed hillsides. The hills are also used for grazing in some of the places. There are no industrial, commercial, transportation or dense traffic activities, music shops and the like that contribute to generation of noises in the area. Hence, the mean noise level in this area is 43.4 ± 0.8 dB (A) which as expected, falls below the guideline values of the Environmental Standards of Ethiopia.

11.3.9 Social

The Project area (located in Kapi Guracho Kebele) of the Genji Woreda, is situated approximately 520 km by road west of Addis Ababa. The sample quantitative household survey covers 8 Kebeles, of which 3 are directly affected by the proposed Project and 5 are indirectly affected by the proposed Project.

According to the sample household survey, the ethnic composition of the population in the area is all in all Oromo. Hence there are no ethnic minorities in the area that need special protection. The religious affiliation of the population in the study area is also almost all in all protestant Christian with 96 %, whereas Orthodox and Muslim constitute only 3 % and 1 %, respectively.

The sample household survey determined that approximately 91.2 % of household heads in the study area are married, 6.7 % are widowed, 1.3 % are single, 0.4 % are divorced and the remaining 0.4 % are separated.

The sample household survey determined that nearly 57 % of the surveyed household heads can read and write.

As rural Ethiopia is mainly a patriarchal society, the population of the study area is mainly male headed. Out of the total of 478 household heads in the sample household survey, 92.5 % are male-headed. Only 7.5 % the households are female-headed households.

Of household heads, 18 % are younger than 30 years of age. Approximately 25 % of households are aged between 30 and 45 years, and approximately 20 % of household heads are between 45 and 60 years of age. Approximately 10 % are older than 60 years.

The dependency ratio of the study area is, therefore, found to be about 101.2 % which is a little bit lower than the regional figure, 103.1 % as depicted by the 2007 Population and Housing Census of Ethiopia. This means that for each 100 persons in the productive age groups there were about 101 young and old dependents to be supported.

Among the population aged ten years and older, the size of the economically active population was found to be 1 467 and that of the economically inactive population was 325 resulting in an activity rate of 82 %. The area is characterised more prominently as a labour market rather than an employment market. The highest proportion (38 %) of economically active persons is engaged in agriculture while unpaid family workers constitute nearly 58 % of the total economically active persons. It is clear that life in these communities is labour intensive, often involving the entire family in agricultural activities. Children are often involved in the livelihood strategies of households, which is an indication of poverty in communities.

Approximately 54 % of the households receive an annual income of more than 2 400 Birr and about 23 % of them get an annual income between 1 200 and 2 400 Birr. The median annual income of the rural households in the Project area was found to be 2 769 Birr, which is equivalent with a monthly income of 231 Birr. With regard to the reported monthly expenditure of households (as per the sample household survey), 41 % earn less than 500 Birr, 34 % earn between 500 Birr and 900 Birr and the remaining 23 % earn more than 900 Birr.

The majority of the housing units (95 %) in the Project area have walls made of wood and mud, whilst the remainder (5 %) have walls made from wood and grass. With regard to roofing, approximately 85 % of the housing units in the Project area have corrugated iron roofs. The remaining 15 % of the housing units have roofs made of grass. It is clear is that households mostly utilise natural materials to construct their houses, and are therefore dependent on their natural environment for materials, an aspect that is often evident in poor communities.

11.3.10 Culture and Heritage

The Project area is close to Caaggo, a recognised ancient iron ore mining site. Historic iron ore mining, smelting, and smithing sites are evidenced by scars, slag, and tool fragments uncovered in Dimma, Yubdo Woreda; Winsa Qacoo, Ayira Woreda; and Caggo and Warra Qallu, Gulliso

Woreda (Burka 2011; Hamrla 1966). Local Genjii district and Ankori territory families traditionally known for pottery and metallurgy products dating back for more than 100 years include the Innagamdi, Innanani, Rufo and Baargii clans. Their widespread presence in Wollega underscores the area's association with traditional technology practices.

Burial sites are dispersed throughout the Project area, and include traditional, Orthodox Christian, Protestant Christian, and Muslim graves. These sites were divided into two categories, namely those located in churchyards and those in isolated cemeteries on private farmsteads or in the compound of habitation sites.

11.3.11 Ecosystem Services

As mentioned previously, the majority of the mine lease area has been transformed to cultivated fields (53 % of total area), with only the rivers and Bushland (12 %) that are still largely natural. The Forest areas (31 %) are largely modified with the forest canopy having been reduced to few scattered individuals of selected woody species like *Polyscias fulva*, *Prunus africana*, *Apodytes dimidiata*, and *Schefflera abyssinica*, and the undergrowth replaced with coffee plants. These modified habitats still provide ecosystem services, albeit it at lower levels.

Both natural and modified land cover types provide a range of ecosystem services which may be adversely affected by the proposed Project. The services on which there is currently a high dependence includes food from crops and wild animals, timber and other wood products, sand, biomass fuel, freshwater, local, regional and/or global climate, water timing and flows, water purification and treatment, habitat for wild plants and animals, and spiritual services.

There are a number of beneficiaries or users of ecosystem services generated within the mine lease area. These include the following:

- **Affected households:** households situated within the boundaries of the mine lease area
- **KEFI Minerals plc:** Company responsible for constructing and operating the Tulu Kapi gold mine
- **Downstream beneficiaries:** Households situated downstream of mine lease area which are dependent on water-related ecosystem services e.g. fresh water
- **Regional beneficiaries:** Households situated outside of the mine lease area that benefit from ecosystem services generated within the mine lease area. This includes for example, households that have cultivated fields or coffee plantations in the mine lease area or local traders who purchase food crops or coffee from affected households.
- **National and international beneficiaries:** The mine lease area is located within an important coffee growing region, which in addition to supplying coffee to local market, also supplies the global coffee market.

The condition of priority ecosystem services is either good or very good, with most services experiencing a negative trend. Note there are some services which are experiencing a positive trend, as result of increased area under cultivation, improved farming techniques, and planting of gum trees around homesteads. Overexploitation and habitat loss, degradation and fragmentation are key non-projects threats to the identified priority ecosystem services. With climate change, hydrological changes are likely to also become a key threat to services in the future.

11.4 ASSESSMENT OF POTENTIAL IMPACTS

11.4.1 Air Quality Impacts

Impacts during construction can potentially result in a degeneration of the ambient air quality due to increased PM2.5, PM10 and TSP levels from land clearing, drilling and blasting, ground excavation and cut and fill operations.

The fugitive emissions released during the construction of the Tulu Kapi mine infrastructure are anticipated to be associated with land clearing, drilling, blasting, ground excavation, cut and fill operations and waste material disposal. The key emissions identified include PM2.5, PM10 and TSP. The level of daily emissions will vary according to the intensity of activity, the type of operation and the meteorological conditions. Furthermore, these fugitive emissions will have a definable beginning and end and will vary according to the construction phase (USEPA, 1995). The impact severity may be high, however, due to the relative short duration (assumed 2 year construction period) and the radius of effect being limited to the immediate vicinity of the Tulu Kapi mining lease area.

During the operational phase of the mine, the following are potential impacts:

- Predicted dust fallout is expected to be very heavy without the implementation of any mitigation measures in most cardinal directions. Moderate to heavy dust fallout (approximately 2 km beyond the mine boundary) is predicted with the implementation of mitigation measures, with dust fallout levels falling within the permissible levels for heavy commercial and industrial.
- Long-term PM10 concentrations (annual average) are in compliance with the WHO annual average guideline for both modelling scenarios.
- Predicted PM10 concentrations are problematic in the short term (daily average) with and without the implementation of any mitigation measures (60 % control efficiency assumed).
- Annual PM2.5 average concentrations are in compliance with the WHO annual average guideline for both modelling scenarios.
- Predicted PM2.5 concentrations are in non-compliance in the short term (daily average) without the implementation of any mitigation measures and in compliance with the implementation of mitigation measures.

In summary, the dispersion modelling simulations display that particulate concentrations are a concern. Suitable mitigation measures must therefore be implemented throughout the mining operations with a special focus on the processing plant, unpaved roads and open pits.

11.4.2 Soils Impacts

The main construction phase and operational phase impacts anticipated are the following:

- Disturbance of soil and erosion
- Sterilisation of soil/land
- Loss of arable land
- Soil erosion and pollution of the streams due to increased turbidity
- Soil contamination due to leaching of soluble chemical pollutants

11.4.3 Terrestrial Ecology Impacts

The main construction, operation, and closure phase impacts anticipated are the following:

- Clearing of vegetation
- Contaminant spillage
- Disturbance of biodiversity due to activity, vibration, and noise
- Habitat degradation due to dust
- Disruption of local migration patterns
- Increased access to previously inaccessible areas
- Increased colonisation by exotic species
- Clearing of vegetation
- Contaminant spillage
- Increased risk of wildlife and in particular avian species becoming entrapped in open vessels, ponds, and tanks as well as being exposed to hazardous substance
- Disturbance of biodiversity due to vibration and noise
- Habitat degradation due to dust
- Disruption of local migration patterns
- Increased access to previously inaccessible areas
- Increased colonisation by exotic species

11.4.4 Aquatic Ecology Impacts

Anticipated impacts from pollution to surface waters and groundwater during the construction, operation, and closure phases include the following:

- Reduced habitat suitability
- Physical disturbance in terms of alterations to current hydrogeological and hydrological and channel properties.

These impacts will directly and indirectly impact wetland biodiversity and habitat integrity, including the following:

- Disturbance or reduction of Wetland Habitat
- Interruption in hydrology (including most specifically a reduction of water quantity)
- Water quality deterioration
- Increased disturbance to physical, water quantity, and water quantity within the wetland systems resulting in an increased invasion by exotic species
- Water quality deterioration due to erosion and sedimentation
- Potential reduction of biodiversity

11.4.5 Surface Water Impacts

Impacts during the construction phase include the following:

- **Increased Erosion and runoff volumes:** The removal of vegetation and topsoil, as well as the compaction of surfaces during construction, will result in increased runoff and erosion from the site, particularly given the steep slopes and high rainfall in the area. Runoff with higher sediment loads and the higher flood peaks will report to the local water courses.
- **Road and drainage line crossings altering the banks and beds of streams:** The construction of the crossings will alter the river banks and the river bed. There is the potential for erosion downstream of the crossings, backwater upstream of the crossings and erosion at the entrance to the crossing structures.
- **Spillage of oils, fuel and chemicals polluting water resources:** During the construction phase, the spillage of oils, fuel and chemicals can result in the pollution of water resources if due care is not taken.

Operational impacts include the following:

- **Catchment Reduction:** The operations at Tulu Kapi will marginally reduce the runoff volume reporting to the local streams. The impact of the mine and water management infrastructure will isolate the polluted areas and reduce the catchment area contributing runoff to the streams. Stream flow reduction will be a consequence of the reduction in catchment areas.
- **Discharge of mine water:** Excess water will be pumped from the pits to the RWDs. Water will be abstracted from the dam for dust suppression in the pit. The balance of the water will be stored in the dam or treated and used elsewhere on the mine. This water could potentially contain heavy metals, hydrocarbons, high suspended solid load, and may be acidic in the long-term with metal leaching (refer to geochemical assessment). The sizes of the dams have been determined to meet the 1 in 50 year spill criterion.
- **Erosion and sediment collection:** With the steep slopes on site and the slopes' tendency to erode it is likely that soils could be regularly mobilised with extreme rainfall

events. This could result in a deterioration of land capability, as well as the accumulation of sediment in the various dams, which could be costly to mitigate.

Closure phase impacts include the following:

- **Open void:** The pits will be left as an open void post-closure. Water is likely to accumulate within the pits, but as the rainfall and evaporation at the site are of approximately the same magnitude, it is unlikely that the pits will spill over. The potential for the pits to turn acidic should be further investigated in water quality studies.

11.4.6 Groundwater Impacts

For a mine development at Tulu Kapi, the following hydrogeological issues have been highlighted:

- Over much of the lease, and within the initial pit area, the bulk hydraulic conductivity of the strata to be mined is low.
- Locally however, fracture zones associated with SW-NE-trending faults have created zones of enhanced hydraulic conductivity. Where these are encountered during mining, groundwater inflows can be expected which may warrant advanced dewatering by ex-pit bores. However, storage within the bedrock groundwater flow system appears to be low, so any high flows should be of short duration.
- In areas where lower hydraulic conductivity strata predominate, mine inflows will be limited and manageable with in-pit sumps. Relatively high hydrostatic pressures may however occur behind pit walls which will need to be considered in pit design with possible demand for installation of horizontal drainage (depressurisation) bores. As the pit is deepened, consideration will also need to be given to potential for floor heave and possible demand for in-pit pressure relief bores.

Effective management of groundwater is required to ensure safe and cost-effective mining operations. To achieve this, dewatering and depressurisation is likely to be undertaken at Tulu Kapi during the life of the mine to ensure dry mining conditions and pit wall/floor stability.

11.4.7 Geochemistry Impacts

Based on the assessment of the static and kinetic test data, the following conclusions have been made:

- Major cation (Ca, Mg, Fe, Mn, Al and Si), trace metal (e.g. As, Cd, Cu, Ni, Pb and Zn) and sulphate (SO_4^{2-}) release rates were generally low or decreased to low levels after a few cycles of testing under neutral pH conditions.

- Though SO_4 and metal release rates were generally low, exceedances of water quality guidelines were noted occasionally for alkalinity, SO_4^{2-}, pH, Ca, Fe, K, Mn and Ni. Arsenic (As, Cd, and Pb, which are also potential COI, was quantified at the analytical method detection limit, which was equal to or higher than the water quality guidelines for the elements.
- Albitised syenite and quartz vein are characterised by higher sulphide sulphur contents, higher AP and are PAG. However, the tested materials revealed a low degree of sulphide reactivity despite the relatively high sulphide content (> 1 %).
- The CaNP rate was consistently higher than acid potential (AP) rate throughout the testing period indicating the slow reactivity of sulphides and availability of dissolving and fast reacting carbonates and silicates. Thus, albitised syenite and low grade ore are not potentially acid generating (Non-PAG) in the short to medium term. However, as the carbonates will be depleted much earlier than sulphides, the low grade ore and albitised syenite waste rock materials are PAG in the long term.

11.4.8 Waste Impacts

The following are the waste impacts:

- **Excavations and removal of topsoil, overburden, vegetation and other waste:** The site will be cleared from any vegetation, excavated and levelled before any infrastructure can be constructed. Some of the soil and overburden will be used for backfilling during construction and the rest strategically stored as berms for future rehabilitation purposes.
- **Management of solid non-hazardous waste materials during construction:** Non-hazardous waste will be generated during the construction phase. These are not only industrial waste materials but also packaging materials, scrap steel, cables, lighting bulbs, paper, containers, plastic etc. Volumes will be high during the construction phase.
- **Management of hazardous waste materials during construction:** Various hazardous waste materials will be generated during the construction phase. This ranges from used solvents, chemical containers, fluorescent tubes, used oil and grease, medical waste from the clinic etc.
- **General household food waste from the kitchen, canteen, offices and temporary staff construction camp:** The magnitude of the impact of household food waste before mitigation is rated as low. Food waste generated at the kitchen and canteen will be temporarily kept in sealable containers and removed on a daily basis to a piggery or for composting purposes.

11.4.9 Noise and Vibration Impacts

The construction and decommissioning phases will create a temporary increase in the prevailing ambient noise levels where it will become more permanent during the operational phase.

During the operational phase of the Project, the blasting will take place three times a week during lunchtime. The noise increase is for a period of 3 seconds per blast only after which the prevailing ambient noise level will be maintained.

The vibration level of 4.28 mm/s is well below the limit where structural damage can occur. The people within a radius of 800 m from the blast will experience the over air pressure more than what the ground vibration is noticed. The over-air pressure shock wave is at times confused with structural vibration. There were during both the above blasts no fly rock experienced at the measuring points although it was visible from the measuring point the fly rock was site specific only.

The noise intrusion during the different mine activities of the construction and operational phases is more within a radius of 500 m from the activities whereas at 2 000 m from the activities the calculated noise levels are in line or slightly above the prevailing ambient noise levels except during a blast when the noise intrusion is exceeding the prevailing ambient noise levels in such a manner that the increase will be widely audible outside the boundaries of the mine.

The ground vibration and fly rock during a blast will have an impact on the houses within a radius of 500 m from the blast depending on the amount of explosives which will be used for the overburden or seam blasts. As a result, the impact of ground vibration and fly rock on houses closest to the pits, particularly those to the north of the smaller mine pit will need to be closely monitored.

The noise impact on the environment and the people residing in the vicinity of the proposed mine will have to be proactively managed during the construction and operational phases. The residents will have to be informed of the anticipated shift in the prevailing ambient noise levels which will be temporary during the construction phase and more permanent during the operational phase.

11.4.10 Visual Impacts

This aspect of the study is primarily subjective, based on the professional opinion of the consultant and industry-accepted standards in visual assessment, based primarily on the information at hand. The landscape is discussed in terms of its value as a visual resource, as well as its perceived ability to absorb or “hide” visual change.

11.4.10.1 Visual Resource Value

The following visual attributes were assessed:

- **Topographic ruggedness and landforms:** The topography of the study area is not characterised by prominent features and is therefore not considered to contribute to its aesthetic appeal or visual resource value.

- **Prevalence of natural landscapes and human-made elements:** The largest part of the study area is characterised by moderate levels of human development. The rural character of the area is appealing.
- **Land use compatibility**: The existing level of land use compatibility is high for most of the study area, which is characterised mainly by rural activities and subsistence agriculture.
- **Sense of place/genus loci:** Sense of place describes the extent to which a site is visually unique or distinctive and can be distinguished from other places, regardless of whether it is considered to be scenically beautiful or not. The proposed mining area has an appealing sense of place, due to the low levels of human development. Agriculture and settlement areas have a localised impact on the genus loci of the study area but do not create a unique character to the site.

Based on the above visual attributes assessment, it is estimated that the study area is of moderate visual resource value.

11.4.10.2 Visual Absorption Capacity (VAC)

The VAC of an area is a function of the visual complexity of the landscape, whether natural or artificial; and is determined by the elements that it is composed of. Landscapes characterised by a greater diversity of shapes, textures and colours have a greater degree of VAC, regardless of whether they are perceived as visually pleasing or not. Landscapes with dense vegetation cover and pronounced topography generally also have a somewhat higher level of visual absorption cover. Based on this premise, the Project area is considered to have a low VAC.

11.4.10.3 Receptor Sensitivity

Receptor sensitivity refers to the degree to which an activity could visually impact on stakeholders, and depends on the number of people that may potentially view the activity, as well as by whom and their perceptions regarding aesthetics. Taking these factors into consideration, the sensitivity of the receptors can be classified for high, moderate or low visual sensitivity.

The majority of visual receptors of the proposed Project are expected to be local villagers, as the site is not located along any major transport routes or near major tourist attractions. The low levels of development therefore mean that relatively few people are expected to be exposed to the Project. It is difficult to accurately estimate their perceptions of the landscape as a visual resource. It is reasonable to assume that the subsistence farmers and others living in nearby villages attach at least some value to the appearance of the landscape. For this reason, visual receptor value in terms of the study area is estimated to be moderate.

On the basis of this qualitative assessment, it was determined that no further study was required with respect to the visual impacts of Tulu Kapi.

11.4.11 Socio-Economic Impacts

The following socio-economic impacts are expected to arise from the construction and operational phases of the Project:

- Influx of population
- Physical and economic displacement
- Loss of livelihoods
- Loss of subsistence food sources and further shift towards market economy through displacement from productive land
- Increased pressure on natural resources and ecosystem services due to mine related activity and land take
- Employment creation
- Perceived increase in skills development and skills transfer
- Perceived economic diversification and improved access to enterprise development
- Improved local and national economy as a result of salaries, procurement and taxes directly and indirectly from the mine
- Perceived increase in cost of living
- Perceived impacts and opportunities for vulnerable groups specifically women, youth and elderly
- Damage to cultural heritage and archaeological resources through land transformation activities
- Limitations of past consultation with I&APs could have adverse effects on future engagement and trust within the local communities
- Potential for misinformation and speculation to increase fears and sense of security
- Safety and security risks
- Macroeconomics economic inputs

During closure, the following socio-economic impacts are expected:

- Loss of employment
- Decline in economic activity
- Change from mining to agriculture

11.4.12 Cultural Heritage

Economic competition with traditional goods from imported products and traders could diminish the livelihoods of traditional merchants and craftsmen without a plan for integrating new and current goods into the local economy. Large scale economic and environmental development will alter aspects of the lives of local inhabitants, including in their material culture.

Some associated impacts to the indigenous belief systems, trees of cultural significance and sites associated with indigenous beliefs are anticipated. In the case of resettlement or relocation, decreased access to traditional environmental resources, dissociation from current social structures, and familial separation could occur.

11.4.13 Ecosystem Services Impacts

During the construction and operational phases, the proposed Project may have an adverse effect on priority ecosystem services, including the following:

- Loss or reduction of identified priority ecosystem services
- Influx of people into the area
- KEFI's social, operational, financial, and reputational risks

The provision of ecosystem services, particularly fodder for livestock and erosion control, is likely to increase with rehabilitation of site post-closure of the mine.

11.5 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

11.5.1 Purpose

The primary aim of the Environmental and Social Management Plan (ESMP) is to mitigate negative impacts and enhance positive benefits of the Project. The ESMP is comprised of a series of individual plans that outline the scope of environmental, social and health management pertaining to compliance with applicable regulatory requirements. It translates the findings and recommendations of the ESIA into clear measures for the management and monitoring of impacts during the three project phases. KEFI will implement, maintain and update the following plans in accordance with the provisions of the ESMP for both construction and operations:

- Air Quality Management Plan
- Noise and Vibration Management Plan
- Water Management Plan
- Waste Management Plan
- Flora and Fauna Management
- Waste Management Plan
- Social Management Plan
- Cultural and Heritage Resources
- Emergency Response Plan.

In time, KEFI will develop and implement an Environmental Management System (EMS) to a recognised standard in accordance with their environmental policies to ensure the management of environmental impacts caused by the Tulu Kapi mine and operations are continually monitored and improved.

11.5.2 ESMP Implementation

KEFI will ensure the availability of the human and financial resources needed to conduct all environmental management, mitigation and monitoring activities at the Tulu Kapi mine throughout the construction, operation and closure phases. As necessary, but primarily during construction, this will include the investment of capital to ensure that environmental mitigation measures such as pollution control equipment are integrated into various project components. KEFI will employ a nine person Environmental Management team to ensure the implementation of the ESMP at Tulu Kapi.

On appointment all contracting companies will receive a copy of the ESMP and Environmental Policy for the Project.

All employees and contractors will receive training on the contents and requirements of the ESMP. An Environmental and Social (ES) awareness plan will be developed by KEFI, prior to commencement each phase of the proposed Project.

Performance assessments of KEFI's implementation of the ESMP will be conducted annually, and will be done by an independent reputable environmental consultancy.

11.5.3 Management Measures

Proposed management measures for construction impacts are provided in Table 11-2, to ensure that the residual adverse impacts resulting from the works will be reduced to an acceptable level, whilst maximising the benefits of the Project.

Table 11-2: Summary of Social and Environmental Management Measures to be Implemented at Tulu Kapi

Management Plan	Measures to be Implemented
Air Quality Management Plan	Dust mitigation and monitoring will be done to prevent the generation of atmospheric dust that would constitute a health hazard or nuisance to people living nearby or those working on-site. The Air Quality Management Plan includes control measures for minimising dust produced on access/haul roads, from the waste rock dumps and overburden stockpiles, during blasting operations, from construction equipment, and material handling sources. In addition, all stationary and mobile equipment will be kept in good working order to minimise emissions.
Noise and Vibration Management Plan	KEFI will implement a number of measures according to the IFC Environmental, Health and Safety (EHS) Guidelines, including: the inspection and maintenance of plant equipment and machinery to ensure that they are properly muffled; use electrical (rather than pneumatic or mechanical) equipment as much as possible; carry out noise monitoring at sensitive receptor locations and site boundaries; will use silencers, acoustic barriers, etc., if noise

Management Plan	Measures to be Implemented
	levels exceed limit levels. Blasts will be designed so that ground vibration levels not exceeding 10 mm/s at houses, particularly those to the north of the smaller pit, and the air over pressure level of 134 dB and 120 dB in the vicinity of schools and/or churches are adhered to.
Water Management Plan	KEFI will develop and implement a Water Resources Management Plan that addresses water withdrawal and/or retainment and utilisation, and discharges. The Plan incorporates measures to ensure that • Water extraction is conducted in agreement with the established environmental protection criteria; • There is an adequate supply of suitable quality water for domestic and operation purposes; • Mining and industrial water is managed in such a way that effluents are not discharged to the environment, including the provision of engineered barriers for facilities that might be acid generating (e.g. TSF and ROM Pad); • Domestic water effluents are treated appropriately prior to release; and • The physical stability of the Tailings Storage Facility, the storm-water Management facility and the Raw Water Diversion Dam is not compromised during the mining lifecycle.
Waste Management Plan	KEFI will be responsible for the development of a detailed waste management plan which will keep waste to a minimum and emphasise the waste management hierarchy of reduce, reuse, recover, treat, or landfill (for non-hazardous materials). All waste will be stored, treated, disposed of and transported in accordance with the provisions of the IFC EHS guidelines. Employees will be provided with training and encouraged to implement waste management practices.
Soils and Land Management Plan	In order to minimise erosion and where feasible each section of work will be progressively mulched and revegetated as it is completed; vehicles will be confined to well-defined roads; adequate road drainage will be provided (based on road width, surface material, compaction, etc.), and the site will be stabilised and erosion controls maintained so that they remain effective during any pause in construction. Upon completion of the work, the effectiveness of soil stabilisation measures will be evaluated and if necessary, stabilisation measures will be taken to protect infrastructure and avoid degradation of the environment. Fuel and oil tanks and dispensing areas will be isolated to capture any spills. Excessive soil contamination by fuel or oil spills, for example, from mining vehicles, will be collected to be treated at a pre-determined and dedicated location, or will be treated in situ using bio-remediation, in accordance with procedures to be developed.
Flora and Fauna Management	Disturbance to terrestrial ecology be kept to a minimum by demarcating the construction areas and restricting construction to these areas only. In addition, replanting of plants and trees of conservation importance, where they were removed, during the construction and operation phases the number of these species removed can be recorded so that the same number can be replanted during rehabilitation or through KEFI's established community reforestation programme. KEFI shall investigate the feasibility of establishing environmental preservation areas. Such areas would have a beneficial contribution to the mitigation measures proposed for the Tulu Kapi Gold mine, specifically biodiversity mitigation measures.

Management Plan	Measures to be Implemented
Social Management Plan	KEFI will maintain ongoing liaison with communities through the implementation of their Stakeholder Engagement Plan throughout the project lifecycle. KEFI will develop, disclose, adopt and implement the following management plans to address the impacts associated with influx and social services and infrastructure: • Influx Management Plan • Community Development Plan (CDP) • Contractor Management Plan • Recruitment, Training and Local Employment Plan • Community Health Management Plan • Environmental and Social Awareness Plan The implementation of the RAP and Livelihoods Restoration Program will further ensure that impacts to livelihoods, access to project restricted areas, etc. is managed efficiently.
Cultural and Heritage Resources	There is potential to unearth artefacts in the Project area during the construction phase of the Project. A Chance Find Procedure will be implemented to address these unplanned discoveries. In case of artefact discovery, work will be stopped in that area and an archaeologist will be notified.
Emergency Preparedness and Response Plan	KEFI will develop and implement a detailed Emergency Preparedness and Response Plan. The Plan shall • Provide a system to manage emergencies on-site • Provide for regular review and update of emergency procedures • Facilitate on-site emergency response and provide appropriate assistance to responding emergency services • Communicate vital information to all relevant persons as soon as possible • Control or limit the effect of an emergency • Minimise adverse effects on people, property and the environment • Continually maintain a high level of awareness and preparedness • Responsibilities will be assigned to the personnel in accordance with the Site Emergency Plan
Closure Plan	KEFI will develop and implement a detailed Closure Plan, following the construction phase of the Project. Adequate financial provisions will be made in consultation with the Ethiopian government to ensure that adequate finances are available for closure. The closure cost is subject to detailed design updates and the closure planning process throughout the life of the mine, as it will be updated to ensure alignment with the rehabilitation measures required. The closure plan will be reviewed and updated at minimum every two years during the life of the mine, and annually during the last 5 years of operation. The primary objectives of the Closure Plan will be • The physical and geochemical stabilisation of all Project components • The establishment of final landforms • The rehabilitation of disturbed areas and habitat using local, native species • The protection of the public, domestic animals and wildlife from injuries that could be caused by access to closed facilities

11.6 CONCLUSION

The current land use consists of limited agricultural and woodlot operations. The no-project option will result in the continuation of such land uses. Although economically viable, the continuation of subsistence agriculture will not provide the level of short-term and long-term diversification of economic growth consistent with growth plans of the FDRE that this Project would offer. The economic benefits of the Project potentially include:

- Increased training, employment, and service provision opportunities for people in the local area
- Improved livelihood opportunities
- Greater social infrastructure development and associated socio-economic development of the Tulu Kapi area and Ethiopia as a whole

If the Project were not to proceed, the additional economic activity, skills development and availability of jobs would not be created. In addition, the gold reserves would remain unutilised and there would be little or no economic growth developing in the region and country. If the Project were not to go ahead there would be no royalties/revenues paid to the Government of Ethiopia.

Social and Environmental impacts are significant without mitigation, but with mitigation, these impacts are reduced adequately and shall be managed, monitored and mitigated throughout the life of the project, and thereafter.

The complete Environmental and Social Impact Assessment (ESIA) report is given in Annexure 11-1.

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SECTION 12 Implementation

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12.1 INTRODUCTION

The successful execution of the Project requires a carefully considered implementation strategy. This includes the development of a competent owner's team, together with the appointment of a well-respected EPCM contractor.

The execution philosophy is described by SENET and should be interpreted as being valid for any reputable EPCM contractor.

12.2 KEFI'S IMPLEMENTATION STRATEGY

The following key activities are included in KEFI's implementation strategy:

- Project management
- Owner's team
- Engineering, Procurement and Construction Management (EPCM) contractor
- Contractor liaison
- Cost control
- Quality control

12.2.1 Project Management

Complete responsibility for the execution of the project will lie with KEFI's full-time project manager. The project manager will have the necessary experience and track record in the successful execution of capital projects in remote African countries.

12.2.2 Owner's Team

The owner's team will include the following personnel as shown in Figure 12-1:

- Project manager
- Construction manager
- Project accountant
- Project controls manager
- Project cost controller
- Clerks
- Site secretary
- Safety manager
- Safety officers
- Environmental manager
- Environmental engineer
- Environmental technicians

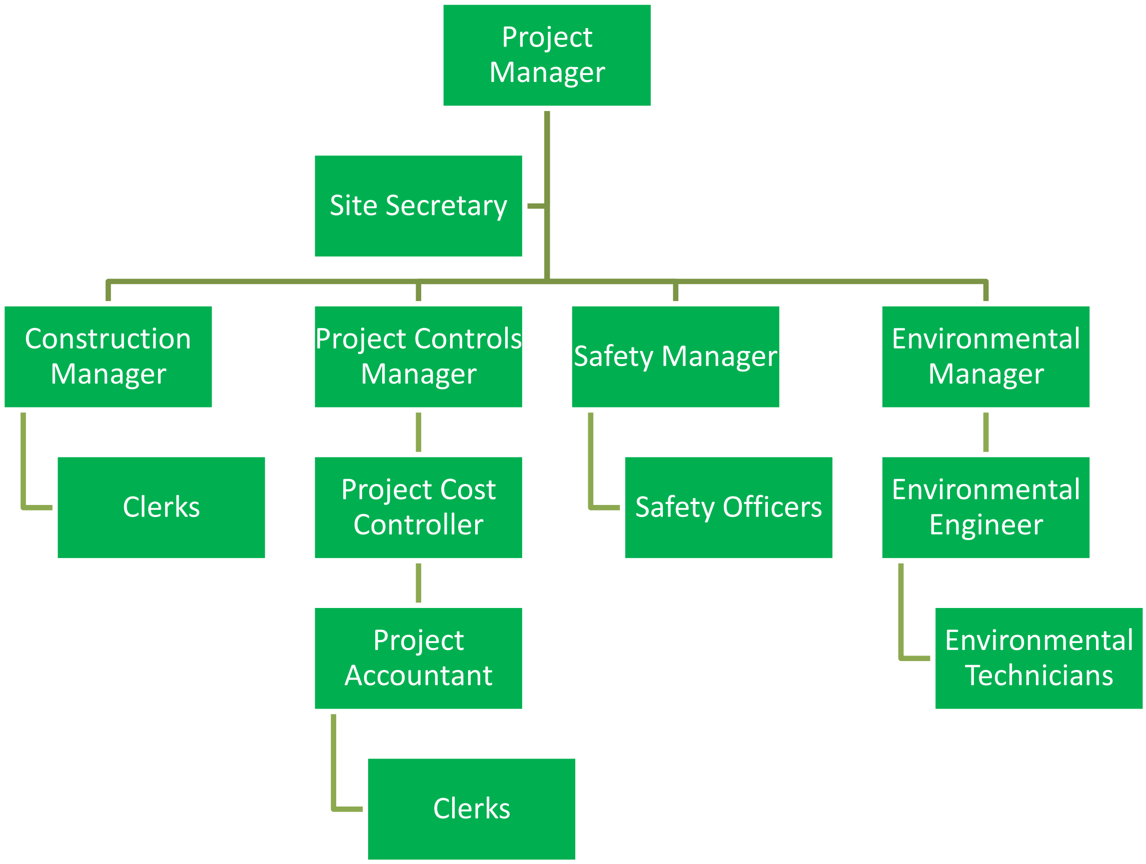

Figure 12-1: Organogram for Owner's Team

12.2.3 EPCM Contractor

An EPCM contractor will be appointed by KEFI. The EPCM contractor's project manager will report to the owner's team's project manager.

12.2.4 Contractor Liaison

The following communication philosophy will be adopted between KEFI and the appointed EPCM contractor:

- Weekly meetings with lead discipline engineers and managers to discuss progress
- Weekly site progress meetings
- Daily site-specific meetings related to safety
- Monthly report prepared by the EPCM contractor with information regarding progress, expenditure, S-curves, and measurement against target

12.2.5 Cost Control

The EPCM contractor and KEFI will each have a dedicated cost controller on the Project to compile all the cost information on a weekly basis. All invoices and variation orders will be signed off by the project manager.

12.2.6 Quality Control

The EPCM contractor will use applicable Ethiopian legislation, and comply with international practice standards.

12.3 ENGINEERING, PROCUREMENT AND CONSTRUCTION MANAGEMENT

Engineering, procurement, and construction management are scheduled to commence following the completion of the feasibility study and finalisation of the contract agreement with the EPCM contractor.

12.3.1 Engineering

The EPCM contractor will establish a project-specific team, as shown in Figure 12-2, to design, produce and check all drawings, technical reports, data sheets, specifications, design criteria and all other documentation required to execute the project.

The EPCM contractor will establish design and engineering control functions through a system of review and approval by the owner's engineering team, followed by submission of the documentation to KEFI for final approval.

The EPCM contractor's standard specifications, design criteria and basis for design will generally be adopted for the project after approval by KEFI. Changes to the approved standard specifications and design criteria will be approved by KEFI.

During the implementation phase, the EPCM contractor will advise KEFI of any additional geotechnical investigations, surveys or other such investigations required.

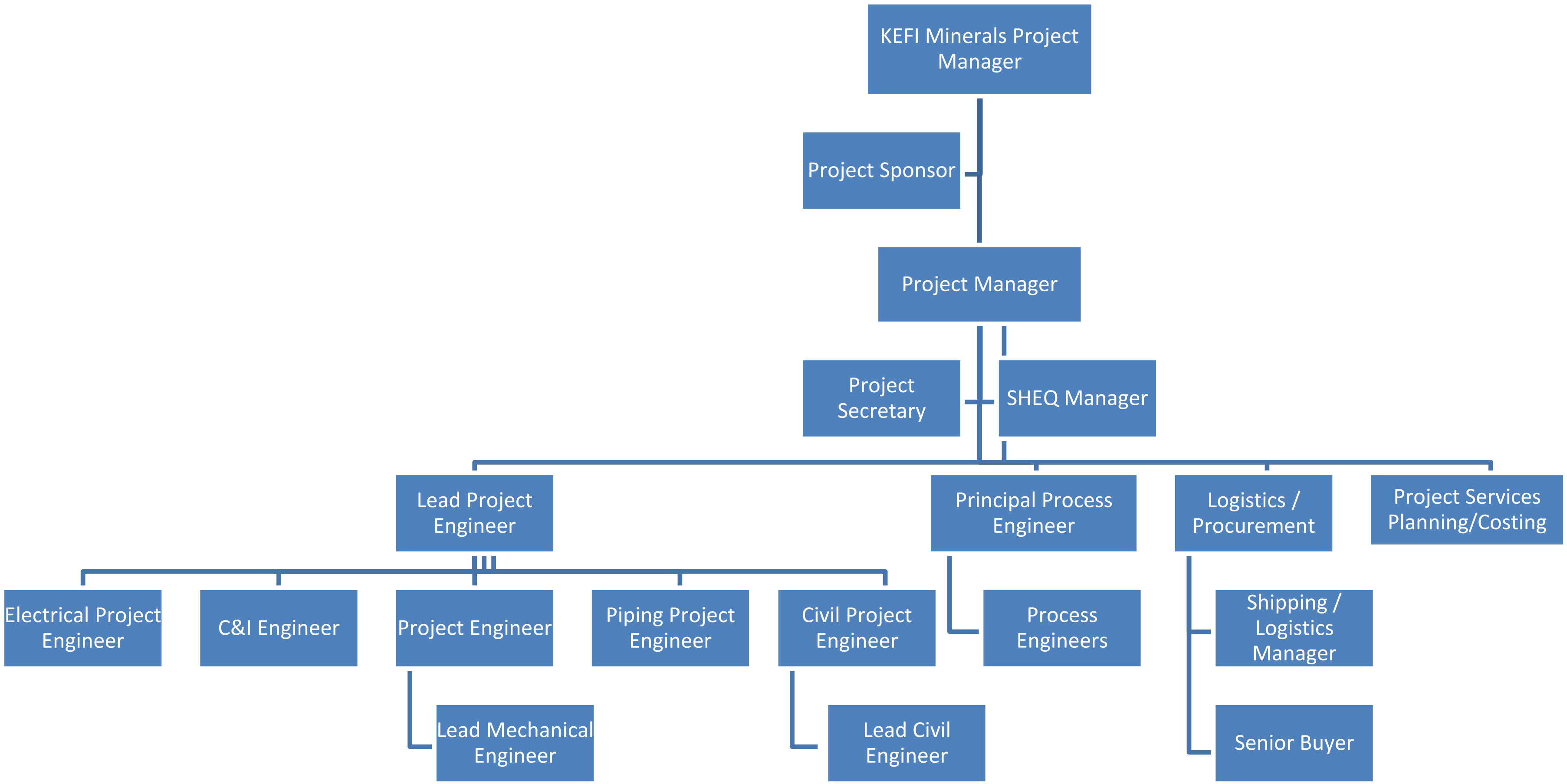

Figure 12-2: Organogram for Design and Management

12.3.1.1 Drawings

Drawings will be prepared in AutoCAD or similar approved compatible computer-aided drafting systems. Drawings include the following:

- Process Flow Diagrams (PFDs)
- Piping and Instrumentation Diagrams (P&IDs)
- Single Line Diagrams (SLDs)
- Electrical schematics
- General Arrangement Drawings (GAs)
- Sections, elevations, and piping isometrics

A drawing register of all the drawings for the Project will be prepared.

Any new drawing will be deemed to include the full design, calculations and schedules upon which the drawing will be based. Copies of all such designs will be made available when required by KEFI.

Hard copies of the drawings will be of true scale, so that all the dimensions will be accurate for the listed scale, and generally prepared on both A0 and A1 size sheets. The drawings will be stamped “Approved For Construction” when applicable.

The drawings to be provided by SENET may be classified into the following five categories:

- Process Engineering
- Layouts and General Arrangement Drawings
- Structural, Mechanical, Electrical, Instrumentation, Piping and Civil Layouts, Sections and Elevations
- Detailed Concrete Design Drawings and Reinforcing Steel Details
- Detailed Infrastructure, Services and Ancillary Drawings

12.3.1.2 Process Engineering

At the outset of project implementation, KEFI and the EPCM contractor will review the feasibility study findings in order to identify any new or revised design requirements. The deliverables of this review will be a process definition with PFDs and P&IDs covering all the processing areas, which will be signed off by the EPCM contractor and KEFI, and be issued for detailed design. This will include a Hazard and Operability (HAZOP) study that will ensure the safe and practical operation of the plant. Process design innovations and options, together with quantitative analyses to enable the project team to evaluate and select the optimum process route and equipment, will be completed during this period.

12.3.1.3 Layouts and General Arrangement Drawings

The layout drawings will include an overall project layout, as well as specific layouts for the process plant terrace and mine infrastructure terrace. General arrangement drawings will be provided to detail the buildings and equipment on these terraces.

12.3.1.4 Structural, Mechanical, Electrical, Instrumentation, Piping and Civil Layouts, Sections and Elevations

Detailed design drawings of the plant and plant sections will be fully dimensioned and include set-out points (SOPs), as well as equipment numbers, masses and capacities, with sufficient elevations, plans and sections to facilitate easy reading and interpretation and will be designed and drawn to the standards and codes of practice as specified. Isometric drawings will be provided for all major piping.

The completed drawings will provide the fabricator/supplier with all the necessary information for complete fabrication/manufacture but will exclude shop detailing normally carried out by the fabricator/supplier.

The civil layouts will provide the general foundation layouts of the plant and plant sections, inclusive of imposed loadings, elevations, coordinates and SOPs.

12.3.1.5 Detailed Concrete Design Drawings and Reinforcing Steel Details

These drawings will include concrete general arrangements and details as well as the associated reinforcing drawings and bending schedules.

12.3.1.6 Detailed Infrastructure, Services and Ancillary Drawings

These drawings will include all the details required for the location and commissioning of all infrastructure, services and ancillary works, including but not limited to buildings, workshops, stores, water, air and power supply, sewage disposal, pipelines, electrical reticulation, communications, roads and hard standings, storm water drainage, fencing, and temporary construction facilities.

12.3.2 Procurement

The schedule assumes that all process equipment will be purchased new and that the longest lead items, the SAG and Ball Mills, will take 12 months from issuance of purchase order to delivery on site (based on the vendor selected in the DFS, and excluding installation and commissioning).

The construction packaging plan will follow a typical breakdown including the following:

- Civil and earthworks, including plant site grading, roads and site services
- Concrete supply and installation
- Mechanical/structural supply and installation
- Electrical/instrumentation supply and installation
- Modular mine building supply and installation

The EPCM contractor will provide all the services necessary for the efficient accomplishment of the procurement requirements for the timely completion of the project, including but not limited to the following:

12.3.2.1 Initial Procurement and Vendor Management

Initial procurement and vendor management, as follows:

- Preparing enquiries and tender documents for approval by KEFI
- Issuing enquiries for quotations and tenders
- Expediting submissions of quotations and tenders and addressing any queries that may arise in respect of enquiries
- Preparing price comparisons and analyses of quotations and tenders, including technical evaluations and comparison of commercial terms proposed
- Preparing price comparisons with the budget where applicable
- Submitting these comparisons to KEFI with recommendations of a supplier or subcontractor
- Obtaining approval from KEFI for the selection of recommended suppliers or subcontractors
- Preparing and awarding purchase orders and subcontracts
- Following up and reviewing order acknowledgments
- Resolving technical, commercial, contractual and other queries raised by suppliers and subcontractors
- Obtaining approval from KEFI on modifications of terms of purchase orders and subcontracts (e.g. deviations of prices and/or payment terms)

12.3.2.2 Expediting and Quality Inspection

Expediting and quality inspection, as follows:

- Expediting delivery of equipment/materials/goods/work, including the fabricators' and the suppliers' drawings, data and sub-orders, if so required
- Ensuring adequate notice is obtained from the suppliers and the subcontractors regarding availability for inspections
- Arranging timely shipment of equipment/materials/goods/work

- Ensuring that shipment arrangements are adequate, including specification of ocean freight arrangements to comply with KEFI's requirements
- Carrying out inspection of equipment/materials/goods/work in progress at the premises of the suppliers, subcontractors, fabricators, manufacturers, etc.

12.3.2.3 Logistics Interfacing

Logistics interfacing, as follows:

- Ensuring that all the required documentation and assistance is given to the suppliers and/or their agents to complete export and/or import formalities
- Receiving equipment/materials/goods/work, including order verification, acceptance, recording of receipts and processing of claims

12.3.2.4 Cost Control

Cost control, as follows:

- Verifying, approving and submitting the suppliers' and subcontractors' invoices to KEFI for approval prior to payment by the EPCM contractor or directly by KEFI, as required
- Informing KEFI of meetings involving procurement and subcontracts
- Preparing, reproducing and issuing procurement documents as required by KEFI in accordance with distribution charts to be agreed between the EPCM contractor and KEFI

12.3.2.5 Project Procurement Materials Control

Project procurement materials control, as follows:

- Preparing/issuing project materials commitment/expenditure statement
- Preparing/issuing project materials progress reports, registers, procurement status reports, inspection reports, expediting reports, and action reports
- Preparing/issuing a monthly summary report of all procurement values subject to exchange rate fluctuation

12.3.2.6 Reporting

Preparing/issuing a monthly status and summary report of amounts committed, amounts paid, rebate and reclaim applications, and received amounts for all value-added tax (VAT), goods and services tax (GST), sales and use tax (sales tax), duties, fees, taxes, etc.

12.3.3 Construction Management

The construction team, shown in Figure 12-3, will use proven systems and procedures to implement and control all the aspects of the site work, interfacing with KEFI as required to satisfy the required scope and responsibilities.

The construction manager will be responsible for ensuring that the work proceeds according to the drawings specifications and project schedules and that quality and workmanship standards are maintained. He or she will also be responsible for the day-to-day site activities, including maintenance of occupational health, safety and environmental procedures.

Construction management responsibilities include the following:

12.3.3.1 Construction Planning, Equipment and Subcontractor Management

This involves the following:

- Providing a construction programme, including a forecast of manpower requirements and temporary construction plant and facilities requirements
- Preparing and submitting applications for construction and related permits
- Preparing construction schedules, including target dates for the individual subcontracts awarded, for the purpose of subcontractor planning against which the subcontractor performance will be monitored
- Controlling the receiving, handling, storage, warehousing and dispatching of equipment and materials and preparing material audits and inventories
- Managing construction drawings and erection drawings submitted by subcontractors, suppliers and fabricators at the job site, for conformity with design
- Informing and consulting with the project manager and site personnel concerning field activities
- Administering subcontracts and co-ordinating the field activities of partners, subcontractors and suppliers
- Managing industrial relations in accordance with procedures
- Monitoring the construction work for compliance with the approved drawings, plans and specifications, and standards of workmanship

12.3.3.2 Quantification and Control of Work Completed

This involves the following:

- Determining quantities of excavation, compacted fill, concrete placed, and structural steel erected, including verification of other measurements as may be reasonably necessary to establish or verify progress

- Providing survey control for subcontractors, from which to set out and establish procedures for checking subcontractors' work
- Providing any additional survey information necessary to complete detailed design of the project
- Comparing reports of subcontractors and suppliers against work actually performed, and approving invoices submitted for payment
- Issuing monthly site progress reports
- Controlling claims, variations, and back charges
- Preparing estimates of cost as required and performing cost coding of construction work
- Maintaining current marked-up drawings reflecting "as built" construction, submitting these to the detailed design engineers, and drawing office for revisions as may be required.

12.3.3.3 Quality Control of Methods Used and Work Completed

This involves the following:

- Monitoring and reporting acceptance testing and contract completion
- Monitoring and administering project environmental requirements
- Monitoring and administering work-site construction safety requirements in accordance with the project safety policy
- Administering work-site security requirements in accordance with the insurer's and KEFI's requirements
- Administering retention instruments and monies withheld from subcontractors' payments by the Client, with an adequate record of individual retentions maintained to comply with KEFI's requirements
- Issuing certificate(s) of practical completion to subcontractors
- Initiating the release of retentions and bank guarantees
- Issuing certificates of final completion as required
- Compiling, monitoring, and reporting all invoices, recordings, returns and payments (albeit reimbursable) associated with the construction subcontracts

The EPCM contractor will, at the appropriate time, set up the construction site area. The required site preparations will be made with the identified contractors and construction services installations will be put in place to enable the site works to commence timeously.

Formal interfacing will occur at regular intervals during the construction activities in the form of progress and technical meetings, and discussions and handling of security issues; all of which shall be recorded.

The construction site area will be laid out in advance of construction activities with designated areas for management and contractor offices and related facilities, construction equipment locations and material/equipment storage, cranage and material laydown requirements.

All contractors will be inducted on safety and related issues and will be self-sufficient and responsible for establishing workshop/storage areas and/or warehousing facilities for their materials and equipment in the designated locations. Access and security controls will be put in place by the contractor.

Quality control and audit procedures will be implemented to ensure and verify compliance with the quality assurance plan. This plan includes head office engineering work, procurement documentation and compliance with vendor quality control procedures, as well as the detailed control of construction contractor standards, which will be covered by a separate quality plan.

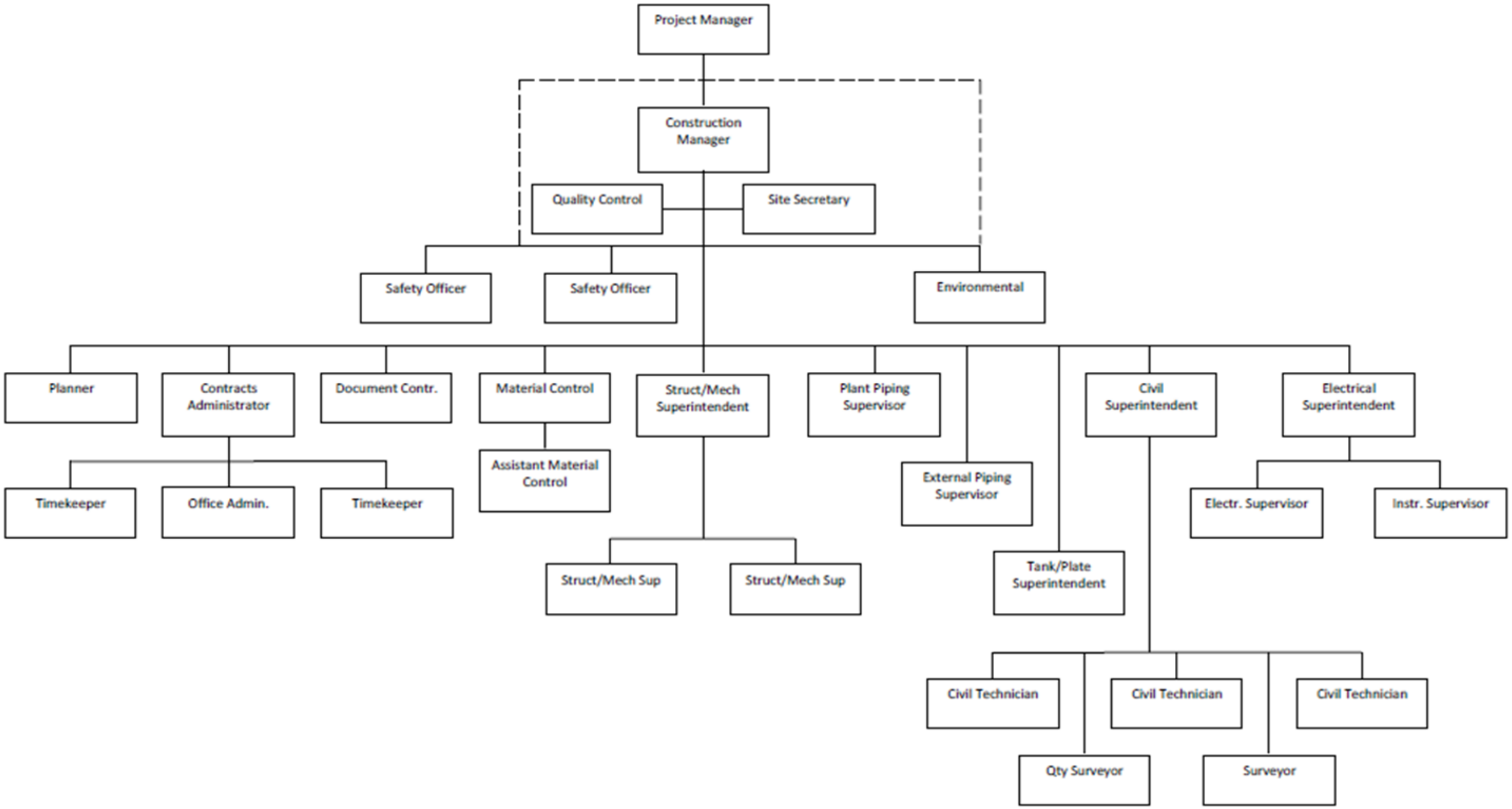

Figure 12-3: Organogram for Construction Management

12.4 CONSTRUCTION

12.4.1 Contracting Strategy

12.4.1.1 Earthworks Contract

Enquiries will be prepared and issued to contractors selected from an approved bidders list. The earthworks contractor will be selected following a commercial and technical adjudication process. The contract will be based on a bill of quantities against which quoted rates will be applied.

The earthworks contractor will provide all the construction equipment, materials and electrical power necessary to complete the works.

The contractor will be responsible for identifying borrow pits for imported fill material. It has been assumed that suitable fill material will be located within 2 km of the construction sites. The earthworks contractor will be responsible for sourcing water for construction.

It has been assumed that sufficient construction water is available from the Birbir River located less than 10 km, by road, from the site. However, the contractor may identify other sources closer to the site which may be used after agreement with the Engineer and environmental personnel.

12.4.1.2 Civil Works Contract

Enquiries will be prepared and issued to contractors selected from an approved bidders list. The civil contractor will be selected following a commercial and technical adjudication process. The contract will be based on a bill of quantities against which quoted rates will be applied.

The civils contractor will provide all the construction equipment, materials and electrical power necessary to complete the works.

All aggregate (both stone and sand) for the purposes of batching concrete shall be the full responsibility of the contractor.

A potential gabbro quarry site has been identified 3 km from the plant site, for the purposes of the DFS it is assumed that this source is suitable in quality and quantity for concrete stone/coarse aggregate. The contractor will be responsible for transportation, exploitation, crushing and screening of the coarse aggregate.

Concrete sand/fine aggregate is available from Gulliso, 31 km by road from the plant site.

It has been assumed that sufficient construction water is available from the Birbir River located less than 10 km, by road, from the site. However, the contractor may identify other sources closer to the site which may be used after agreement with the Engineer and environmental personnel.

12.4.1.3 Structural, Mechanical, Platework and Piping (SMPP) Works

Enquiries will be prepared and issued to contractors selected from an approved bidders list. The SMPP erection contractor will be selected following a commercial and technical adjudication process. The contract will be based on a bill of quantities against which quoted rates will be applied.

All equipment and materials for incorporation into the works will be free-issued to the SMPP erection contractor. Construction cranage and vehicles will be made available free of charge, however, the SMPP construction contractor will provide all the construction power and consumables.

12.4.1.4 Electrical and Instrumentation (E&I) Works

Enquiries will be prepared and issued to contractors selected from an approved bidders list. The E&I contractor will be selected following a commercial and technical adjudication process. The contract will be based on a bill of quantities against which quoted rates will be applied.

All equipment and materials for incorporation into the works will be free-issued to the E&I installation contractor. Construction cranage and vehicles will be made available free of charge, however, the E&I installation contractor will provide all the construction power and consumables.

12.4.2 Site Establishment

12.4.2.1 Site Personnel Availability

Due to the worldwide demand for skilled technical personnel, recruitment of construction personnel from other parts of Africa and Southeast Asia will be explored.

Leave rosters for expatriate construction personnel will be based on a cycle of eight weeks on site followed by two weeks leave.

12.4.2.2 Site Travel

All travel to and from the site will be managed from the site, but arranged in the EPCM contractor's head office. Careful planning will minimise travel costs, as groups of people rather than individuals are often brought to site.

The contractor will make use of a travel insurance policy covering the costs incurred should somebody need to be evacuated due to a medical condition. The EPCM contractor will assist KEFI in putting an emergency evacuation policy in place, to cover circumstances that would necessitate the evacuation of the construction crew.

12.4.2.3 Site Infrastructure and Facilities

As part of the provisions of the enquiry, the contractor will, in consultation with KEFI, facilitate and provide for the completion of all buildings and facilities to be used during construction, including, but not limited to, the following:

- Temporary office accommodation and furniture for the site management team
- Temporary ablution facilities at the plant construction site for use by the EPCM contractor's construction personnel
- Reticulation of site office and construction area power, raw water and potable water supplies for the EPCM contractor's and the subcontractors' offices and buildings, as well as for executing the works
- Temporary roads and services
- Regular watering of gravelled and access areas to reduce the dust hazard throughout the construction period
- Limiting site access to only those vehicles necessary for executing the works
- Temporary warehousing and storage
- Provision of communication equipment

Provision will also be made for project expenses required for the efficient construction management of the works.

12.4.2.4 Site Security

The construction site, as well as adjacent laydown areas, will be fenced off and regular patrols will be set up around the site perimeter. Access control, together with visible random searches, will minimise the risk of loss due to theft. It is envisaged that KEFI will engage a local company to provide these security services. In remote areas of the plant (i.e. overland pipelines and overhead power lines) night watchmen may be required to supplement the regular patrols.

12.4.3 Construction Planning

The EPCM contractor will conduct reviews to determine and improve the practicality of the construction plans in order to avoid on-site construction problems, delays, and change orders.

To conduct these reviews, a team composed of the project management and technical staff familiar with the type of facility concerned, will be assembled. The Client's staff members will also provide input into the review process.

12.4.4 Client Coordination

KEFI will be invited to attend regular co-ordination and planning meetings convened by the EPCM contractor.

12.4.5 Materials Control

The materials controller, with the aid of a team of trained yardmen and store men, will ensure a tight control on shipments to site, as well as the storage thereof and will issue such items to the construction crew when required. Daily feedback on the arrival of items to site will enable the contractor's head office to track all goods. All items shipped will be properly tagged and colour-coded per area, making it easy for the site materials controller to keep together equipment destined for the same areas in the plant.

12.4.6 Plant and Equipment

The EPCM contractor will liaise with the earthworks, civils, SMPP and E&I contractors to ensure that sufficient material and equipment will be available to start construction.

Items such as an aggregate crusher, sand washing plant, and a concrete batch plant will be included in the civil contractor's scope of work.

12.4.7 Industrial Relations Management Plan

The EPCM contractor will be responsible for the industrial relations management of his employees and of the employees of his subcontractors and suppliers on the work site. The contractor will also be engaged in the performance of the work, and will comply with and abide by the industrial relations management plan that will be produced after contract award. The plan will be aligned with KEFI's industrial relations policy.

12.4.8 Financial

Site expenses will be managed by the EPCM contractor's construction manager and his staff. Day-to-day expenses will be paid from site petty cash and reconciled on a monthly basis. Larger contract payments to subcontractors will be approved on site and sent through to the EPCM contractor's head office for payment.

12.4.9 Safety, Health, Environmental and Quality (SHEQ)

Motivated employees are considered a most valued asset, therefore, the EPCM contractor and KEFI will undertake to do the following:

- Safeguard them as far as is reasonably possible from injury or damage to health.

- Compile, implement and communicate integrated business management systems to ensure compliance with statutory and KEFI policies in the following fields:

    - Health and safety management
    - Environmental management
    - Quality management

- Provide an opportunity for training and progressive awareness of the SHEQ management systems and associated regulations.
- Ensure that the employees are informed of and comply with the above management systems and associated regulations.
- Ensure that the construction management team and the employees are committed to continuously finding ways of improving the overall business management systems.
- Take a zero tolerance approach to unsafe practices at all times. One or more safety officers will be appointed as part of the construction management team.
- Ensure that the construction management team is totally committed to ensuring safety and hazard management on the construction site, as well as complying with environmental requirements and considerations.
- Ensure that the construction management team is committed to achieving the highest performance in occupational health and safety with the aim of creating and maintaining a safe and healthy working environment. To achieve these objectives, a safety officer will be on site and, together with the construction management team, will provide continuous support and leadership in the following:

    - Complying with all the relevant laws, regulations, standards and specific Client requirements
    - Continuous training and development of employees
    - Ensuring that the health and safety of the community at large are not prejudiced by the construction activities
    - Carrying out risk assessments on critical areas of construction to minimise those risks that are likely to arise

The construction management team will be responsible for the safety of the works and all personnel on the work site. They will ensure that all the employees, partners, suppliers and any subcontractors' employees, at any tier, engaged in the performance of the works, or any individuals on the work site, observe a safe system of work at all times. The safe system of work will be in accordance with relevant acts, regulations, by-laws, rules or procedures and will adopt known and accepted safe working practices together with specific Client requirements. The same will apply for environmental matters.

The agreed health and safety programme will be based on generic products and services, which will include but not be limited to the following:

- Structured identification, measurement, evaluation and control tools
- A "ready-to-go" framework containing all the elements necessary to run an effective SHEQ programme
- Elements divided into practical and easy-to-manage standards and sub-standards. Each standard is weighted to support objective compliance measurements (in-house and NOSA).
- Organisational guidelines to ensure compliance with resource requirements, and appointments in line with organisational policy requirements
- Documentation and support products to implement, measure, and control compliance with the relevant standards
- Practical means to effectively allocate and monitor responsibility areas
- Employee participation and communication using health and safety representatives and committees.
- Training, training materials and support products that provide details on standards and compliance methods to achieve the required competency levels throughout the organisation, job levels, and categories
- Training for in-house audit teams so that progress can be measured on an ongoing basis
- Consultant services, formal audits, recommendations and reports
- Visible recognition in the form of audit certificates and display board decals, which indicate star ratings (valid for a twelve-month period)
- Awards for individuals (e.g. safety achievers, health and safety representatives) and other merit awards

12.5 COMMISSIONING

12.5.1 Approach

The commissioning approach will be based on the following four basic phases as described in a typical enquiry document:

- Pre-commissioning
- Cold commissioning
- Hot commissioning
- Training and operational assistance period

The completion of each phase will be signified by the appropriate documentation and each phase will be completed before progressing to the next phase. Whilst it is preferable to complete each phase for the entire plant before progressing, in fast-track situations, the plant may be split into subsections or functional systems.

As commissioning progresses through the phases, the management and contractual responsibilities change. Where subsections, components or subsystems are used, careful planning will be required to ensure the corresponding changes of responsibility.

The EPCM contractor will prepare a detailed commissioning manual identifying the following:

- Commissioning procedures
- Test data and record sheets to be used
- Commissioning team
- Commissioning schedule

Each phase is briefly outlined below.

12.5.2 Pre-Commissioning

Pre-commissioning is broadly defined as mechanical completion or construction completion. It signifies that the equipment, components and/or systems have been completed in terms of the design, P&IDs, installation instructions and project specifications. It also signifies that the equipment, components and/or systems are ready for start-up.

Each piece of equipment, component and/or system has a checklist, which is completed and signed off by the responsible person.

The checklists will be kept in the site office under the control of the construction manager. Once completed, these checklists will be retained in the overall project files.

The signatures required on these checklists will be specified in the project procedures manual by the project manager. Overall responsibility for pre-commissioning lies with the construction manager, although he may, with the project manager's approval, delegate this responsibility to the relevant area construction supervisor. Normally, signatures will be required from the relevant construction subcontractor, area construction supervisor, construction manager, and KEFI representative. Signatures should also be obtained from vendors wherever possible.

12.5.3 Cold Commissioning

Cold commissioning is broadly defined as non-service testing. It signifies that the equipment, component and/or systems have been tested in terms of the leak testing, non-load running, volumetric/pressure requirements, and project and process specifications. It also signifies that the equipment, component and/or systems are ready for service testing.

Cold commissioning consists of the following:

- All drives will be direction tested and, where not detrimental to the equipment, will be run under no-load conditions for 24 hours with regular monitoring of critical variables. These will be defined for each drive, but will normally include temperature, oil leakage, bearing noise (qualitative) and superficial vibration (qualitative if acceptable, quantitative where required).
- Piping will be flushed. Tankage will be drained and flushed. Subsystems will be water balanced, interlocking and control systems will be checked, and instrument function will be checked and calibrated (where possible).
- Conveyors will be trained and tensioned. After running the conveyors, mechanical checks will be repeated where required. This will include V-belt tension, alignments, etc.
- The drives' power consumptions, temperatures, etc. will be re-checked and compared to readings from the water-testing phase.
- Flow and pressure measurements will be taken and recorded.
- Each piece of equipment, component and/or system has a checklist, which is completed and signed off by the responsible person. The checklists will be kept in the site office under the control of the commissioning manager. Once completed, these checklists will be retained in the overall project files.
- The signatures required on these checklists will be specified in the project procedures manual by the project manager.
- Overall responsibility for cold commissioning lies with the construction manager, although he may, with the project manager's approval, delegate this responsibility to the relevant area construction supervisor.

12.5.4 Hot Commissioning

Hot commissioning signifies the introduction of ore to the process plant.

Each section of the plant will be performance tested. Although the whole plant may be run simultaneously, the proof testing of each section will be undertaken sequentially to ensure a logical progression.

Although the commissioning manager and assistants will provide the overall supervision, direction and technical assistance required during this phase, the operational staff and labour will be provided by KEFI, and the overall legal responsibility will rest with the Client's representative.

On completion of the hot commissioning phase, the plant will be subject to the performance tests as required by KEFI. The maintenance responsibility changes from the contractor to KEFI at the start of this phase.

All equipment warranties and guarantees apply from the commencement date of hot commissioning. Compliance with the SHEQ requirements is the responsibility of KEFI during this phase and thereafter.

12.5.5 Training and Operational Assistance

It is assumed that the plant operators and maintenance staff would have undergone training prior to commissioning.

The EPCM contractor will be expected from commencement of commissioning until completion of performance testing to assist the Client's operations and maintenance (O&M) personnel. During this period, the EPCM contractor will provide technical support in the form of hands-on training and the provision of technical information where required.

Where required in areas such as milling, centrifugal gravity concentrators, intensive leach reactors, etc., vendor training will be provided.

For the site implementation phase, the contractor will introduce a management team to site. This team of people, headed by an experienced EPCM construction manager, will be responsible for the day-to-day management of the construction activities on site.

12.6 PROJECT SCHEDULE

The overall project execution schedule summary for the Tulu Kapi Project is shown in Figure 12-4. The schedule is broken up into the following key work breakdown structures (WBS):

- Resettlement Action Plan
- Process plant
- Mine infrastructure (administration office, clinic, warehouse, workshop, fuel farm)
- Power line
- Mine fleet
- Raw water diversion dam
- Main access routes
- Tailings storage facility
- Main village

Key project milestones include the following:

- Project start — Month 0
- Commence with design and engineering — Month 0
- Commence with new 132 kV EEPCo power line design — Month 1
- Commence with process plant bulk earthworks — Month 4
- Commence of access roads — Month 5

• Completion of raw water diversion dam	Month 8
• Completion of TSF	Month 11
• Commence with pit pre-strip	Month 16
• Completion of access roads	Month 16
• Completion of process plant construction	Month 20
• Completion of process plant commissioning	Month 21
• First gold from process plant	Month 22

The schedule assumes that there is a seamless advancement of the project between the various phases of the project.

The schedule has been based on the following project approach and assumptions:

- The overall approach to the project was to identify the main stream of activities required to execute all the phases of the project and their associated sub-tasks.
- Cognisance has been taken of the amount of rain typically experienced in this region of Ethiopia and the effect this will have on progress. This will have the greatest impact on road construction and earthworks, but all disciplines will be affected to some extent. The construction schedule is based on a rain calendar which allows for 14 non-working days per month during the peak rainy season from June to September and 6 non-working days per month during the off-peak rainy season.
- It has been assumed that access for construction will be gained via the existing road.
- In the development of the project execution schedule, the KEFI mine production schedule requirements have been taken into account.
- Durations for the supply of the key mechanical equipment were based on information supplied by the various vendors during the CAPEX estimation procurement process.
- Project milestones were identified and listed.
- The standard 8-week duration for shipment and transportation of equipment from supplier to site was used throughout the schedule.
- The WBS was created using defined process and infrastructure areas.

The following consultants had an input in the development of the implementation schedule:

• KEFI/Snowden:	Mine pit development and mining infrastructure
• SENET:	Process plant and infrastructure
• GOLDER:	Raw water diversion dam (RWDD)
• GOLDER/Epoch:	Tailings storage facility (TSF)
• GOLDER:	Roads

Figure 12-4: Project Schedule Summary

SENET 25 EST. 1990

Excellence in EPCM for over 25 Years

KEFI MINERALS

SECTION 13 Capital Cost Estimate

Tulu Kapi Gold Project
Definitive Feasibility Study
July 2015

Golder Associates

epoch resources

SNOWDEN

25 YEAR JUBILEE SENET COMMITTED TO EXCELLENCE

Scoping Studies | Prefeasibility Studies | Feasibility Studies | Engineering | Procurement and Logistics | Construction Management | Commissioning

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13.1 INTRODUCTION

The study will be used to determine the commercial and technical feasibility of the Tulu Kapi Gold Project as an owner-operated open-pit mine, with a conventional grinding, CIL plant designed to process 1.2 Mtpa. In order to carry out the necessary analysis, sufficient design, scheduling and equipment costing has been carried out to prepare capital cost estimates to an accuracy of + 15 % to -10 %.

13.2 RESPONSIBILITIES

In the following responsibilities for the estimate apply:

- Mining – Snowden
- Mining infrastructure – SENET/KEFI
- Process plant and process plant infrastructure – SENET
- Tailings storage facility (TSF) - Epoch
- TSF pumping and piping – Golder
- Raw water storage facility and associated pumping and piping – Golder
- Seepage dam and associated pumping and piping – Epoch
- Boreholes and associated pumping and piping - KEFI
- Village – KEFI/C.C.C. Construction
- Access roads outside the mining concession – KEFI/C.C.C. Construction
- Explosives magazine construction - KEFI
- Environmental management - Golder
- Resettlement – KEFI
- Closure - KEFI/SENET

13.3 EXCLUSIONS

The following have not been included in this estimate:

- Escalation beyond Q1 2015
- Financing costs
- Scheduled delays such as those caused by the following:
    - Scope changes
    - Unidentified ground conditions
    - Labour disputes
    - Environmental permitting activities
- Taxes and duties
- Permits
- Sunk costs

- Currency fluctuation
- Force majeure
- Import duties

13.4 EXCHANGE RATES

Table 13-1 shows the rates of exchange used for the DFS. These were based on historic period average daily bid rates (@ ± 0%) between 1 January 2015 and 31 March 2015, sourced from the OANDA Corporation website and agreed with KEFI.

Table 13-1: DFS Rate of Exchange

Currency	Rate of Exchange (US$ bid)
Ethiopian Birr (ETB)	20.0926
South African Rands (R)	11.7328
Great Britain Pounds (£)	0.6597
Japanese Yen (JPY)	119.15
Australian Dollars (AUD)	1.2699
Euro (€)	0.8871

13.5 CAPITAL COST SUMMARY

The total estimated initial capital cost is **US$ 175.6 million,** which is inclusive of contingency and is summarised in Table 13-2.

Table 13-2: Capital Cost Summary

Description	Initial Capital Cost (Incl Contingency) (US$,000)	Sustaining Capital Cost (US$,000)
Mining		
Mining Equipment/Fleet	21,175	26,043
Capital Development	3,044	559
Pre-Strip	15,586	0
Sub Total Mining	**39,805**	**26,602**
Processing Plant & Site Infrastructure		
Process Plant Direct	49,144	2,204
Process Plant Indirect	4,979	0
Site Infrastructure	11,184	0
Plant Operational & Insurance Spares	1,407	0
EPCM & Insurance	10,753	0
Sub Total Plant & Site Infrastructure	**77,467**	**2,204**
Off-Site Infrastructure		
TSF	8,186	15,703
Raw Water Dam and Delivery System	3,828	0
TSF Slurry Delivery & Return System	1,239	0
Overhead Power Lines	11,581	0
Mine Camp	3,520	0
Access Roads	7,700	0
Sub Total Off-Site Infrastructure	**36,054**	**15,703**
G&A Infrastructure		0
Owners Costs	8,854	0
Working Capital	5,481	0
Relocation / Resettlement	7,415	1,330
Environmental Management	525	0
Closure Costs	0	11,863
Sub Total G&A Infrastructure	**22,275**	**13,193**
Total Capital Cost	**175,601**	**57,702**

13.6 MINING CAPITAL COST ESTIMATE

13.6.1 Basis of Estimate and Assumptions

The following technical documents form the basis of the capital cost estimate for mining:

- Mine design for various stages of the Tulu Kapi pit
- Waste rock landform designs and staged development
- Mining sequence of the Tulu Kapi pit and associated waste rock landform construction
- The life-of-mine material movement schedule informed by the mining sequence

- Effective operating time estimates
- Equipment productivity estimates
- Equipment availability estimates
- Vendor quotations for plant and equipment specific for the project
- Unit costs provided by SENET for similar items of plant and infrastructure works
- Historical costs for minor plant and equipment
- Provisional sums for minor costs.

The following assumptions were made in the preparation of this estimate:

- Equipment delivery and commissioning timeframes can be achieved.
- Payments are made upon commissioning of equipment.
- Adequate space is available for large machines to be reconstructed on site.

Mining capital costs were estimated from equipment vendor quotations. Requests for budget quotation were issued to recognised vendors with in-country representation:

- NEFC Caterpillar
- Moenco – Komatsu
- Liebherr Export AG
- Hagbes – Hitachi
- Atlas Copco Eastern Africa Limited
- Advanced mining UAE – Sandvik
- AEL Explosives

Both capital and operating costs were requested from the vendors and responses were received from most of those listed; however, where a company was unable to provide operating costs the quotations were set aside.

The capital estimate allows for the majority of the earthmoving equipment to be purchased from Komatsu with blast hole drills to be sourced from Atlas Copco. Minor equipment was sourced from a variety of locations throughout the world. A summary of the overall mining capital cost estimate is provided in Table 13-3 and a summary of the capital equipment cost build-up is provided in Table 13-4.

Table 13-3: Mining Capital Cost Estimate Summary

Description	Initial Capital Cost (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl. Cont.) (US$,000)	Sustaining Capital Cost (US$,000)	Total Capital Cost (US$,000)
Mining Equipment/Fleet					
Equipment (incl. delivery)	19,058	2,118	21,175	26,403	47,218
Capital Development					
Explosives Magazine Terrace	623	0	623	0	623
Computers and Software/Software Licensing	135	0	135	0	135
Engineering/Geology Equipment	159	0	159	0	159
Shop Tools	200	0	200	0	200
Mobilisation of Explosives Contractor	250	0	250	0	250
Initial Spare Parts	1,677	0	1,677	559	2,236
Sub Total Capital Development	**3,044**	**2,118**	**3,044**	**559**	**3,603**
Pre-strip	14,027	1,559	15,586	0	15,586
Sub Total Pre-strip	14,027	1,559	15,586	0	15,586
Total Mining	**36,129**	**3,677**	**39,805**	**26,602**	**66,407**

A procurement schedule was developed based on increase in fleet requirements as the project ramped up as well as replacement of fleet to maintain reasonable serviceable life of fleet.

Limited replacement equipment was estimated to be required for the project. This is largely due to the relatively short duration of peak output (i.e. material movement) from the pit, after which the demand on equipment falls and there will be multiple assets parked with reasonable serviceable life remaining.

Estimation of earthwork requirements have been determined using Western Cost Models, and estimated on the basis of required infrastructure. Determination of thickness for foundations, weights and designs appropriate for their use have been derived in places by similar experiences. The designs are expected to meet required engineering standards.

Table 13-4: Mining Equipment Capital Cost Estimate Summary

Description	Size / Class	Make	Model	Supplier	FOB Port of Dispatch	Sea Freight to Djibouti[1]	Road Transport to Tulu Kapi[1]	Assembly & Commissioning[1]	Fire Suppression[1] Systems	Contingency	Total Cost Per Machine
Komatsu											
Excavator - back hoe	200 t	Komatsu	PC2000-8	MOENCO	1,820,747	109,000	90,569	50,000	52,876	212,319	2,335,511
Ridged Body Dump Truck	90 t	Komatsu	HD785-7	MOENCO	974,154	39,900	75,606	35,000	27,720	115,238	1,267,618
Excavator - back hoe	120 t	Komatsu	PC1250-8R	MOENCO	757,959	66,000	76,909	35,000	41,808	97,768	1,075,444
Rigid Body Dump Truck	55 t	Komatsu	HD465-7R	MOENCO	510,801	33,000	42,337	0	21,826	60,796	668,761
Front End Loader	6.4 m3	Komatsu	WA600-6R	MOENCO	521,507	22,000	40,327	0	27,720	61,155	672,710
Wheel Dozer	11.5 m3	Komatsu	WD600-3A	MOENCO	461,370	20,000	37,963	0	21,826	54,116	595,274
Track Dozer	17' Blade	Komatsu	D375A-5	MOENCO	626,213	31,000	41,753	5,000	27,720	73,169	804,855
Track Dozer	15' Blade	Komatsu	D275A-5	MOENCO	440,769	15,000	33,283	5,000	27,720	52,177	573,949
Water Cart – Ridged	30 kl	Kom/Groundforce	HD325-7 No Body	MOENCO	514,579	67,000	26,643	25,000	21,826	65,505	720,553
Grader	16 ft	Komatsu	GD825-2	MOENCO	386,394	19,000	21,884	0	21,826	44,910	494,015
Excavator - back hoe	43 t	Komatsu	PC450-8R	MOENCO	222,450	26,000	27,588	0	27,720	30,376	334,134
Rock breaker	43 t	Komatsu	PC450-8R cw H180E S Hammer	MOENCO	323,330	28,000	30,457	0	27,720	40,951	450,458
Tool Carrier	14 t lift	Komatsu	WA380-5	MOENCO	252,171	83,000	16,619	5,000	19,383	37,617	413,791
Tyre handler	14 t lift	Komatsu	WA380-5	MOENCO	328,171	87,000	16,619	5,000	19,383	45,617	501,791
Skid Steer loader	1.7 t lift	Komatsu	SK820-5E0	MOENCO	45,970	3,000	13,740	0	18,664	8,137	89,512
Backhoe	8.2 t	Komatsu	WB97R-5E0	MOENCO	84,979	9,000	13,880	0	18,664	12,652	139,175
Fuel Truck – Rigid	19 kl	Kom/Groundforce	HD325-7 No Body	MOENCO	729,579	67,000	42,337	25,000	21,826	88,574	974,316
Atlas Copco											
Top Hammer Drill	25 kW	Atlas Copco	T45-10	Atlas Copco Eastern Africa Limited	650,000	18,000	22,188	0	27,720	150,761	868,669
RC Drill	435 psi @ 995 cfm	Atlas Copco	D65 - RC	Atlas Copco Eastern Africa Limited	1,250,000	18,000	22,188	0	27,720	276,761	1,594,669
Caterpillar											
Stemming truck	15 m3	Ground Force	STEMMING TRUCK BODY (Ground Force)	NEFC	373,642	29,000	21,882	5,000	21,826	45,135	496,485
Standpipe	220 l/sec	Megacorp	MMP4, Mega Mobile Pump (MegaCorp)	NEFC	64,163	11,614	5,000	0	0	8,078	88,855
Other											
Lighting Tower	3800 m2	Tower Light	VT-8m	Pilot Crushtec	34,245	5,000	2,500	0	0	8,767	50,512
Crane 25 t	25 t	Franna	MAC 25-4 SL	TBA	227,700	10,000	15,000	0	18,664	56,987	328,351
Crusher for road base and stemming	20-30 m3/hr	Pilot Crushtec		Pilot Crushtec	636,639	20,000	20,000	0	0	142,094	818,733
Ute Hilux - Single Cab		Toyota	Hiluz Single Tray Back	TBA	31,007	2,000	500	0	500	7,142	41,149
Ute Hilux - Twin Cab		Toyota	Hiluz Twin Cab Tray Back	TBA	30,504	2,000	500	0	500	7,036	40,540
Landcruiser Wagon		Toyota	troop carrier	TBA	54,444	2,000	500	0	500	12,063	69,507
Mini Bus 22 Seater	15 Seat	Toyota	Caoster	TBA	53,084	5,000	1,000	0	1,000	12,618	72,702
Keto 150 l/s pump 150 m Total Head	150 l/s	Truflow	150/150 Vac - Prime	TBA	150,000	5,000	2,000	0	1,000	45,906	264,506

13.6.2 Pre-production and Pre-strip

Mining pre-production allows for the generation of waste rock required for the construction of the following site infrastructure:

- Stage 1 ROM pad and stockpiling area
- Mine access road and haul roads
- TSF Phase 1A and Phase 1B
- Raw water diversion dam.

It should be noted that these costs only allow for the delivery of bulk waste material to the construction site and do not include the placement, conditioning and compaction that is required or any other associated work. These costs were included as part of the process plant and site infrastructure capital cost estimates.

Haul road construction also includes provision for forming the road and the placement of roadbase. Compaction is expected to be achieved through movement of heavy mine vehicles over the surface.

The pre-production works also allows for clearing and grubbing and top soil removal over the borrow area, ROM pad and mine access and haul roads.

A short pre-strip phase is included in the mining costs to develop the pit and create sufficient surface stockpiles so that ore feed can be maintained to the process plant over the life of the project. It also enables certain high-grade areas to be brought forward to aid project cash flow. The pre-strip and mine pre-production capital cost estimate is provided in Table 13-5.

Table 13-5: Pre-strip & Mine Pre-production

Description	Initial Capital Costs (including Contingency) (US$,000)
Plant Operating Cost	
Primary Fleet	5,544
Ancillary Fleet	982
Minor Equipment	191
Light vehicles	355
Total Plant Operating Cost	**7,073**
Materials	
Drilling Consumables	227
Explosives	1216
Road base	107
Total Materials Cost	1550
Mining Management	487
Mine Technical Service Department	748
Operators	1,017
Mine Maintenance	962
Total Labour Cost	**3,214**
Mining Overheads	
Explosive into the hole delivery service	1,005
Grade Control (assay and consumables)	194
Tech support and training	159
General mining expenses	159
Mine Workshop operating costs	108
Total Mining Overheads	**1,626**
Contractor Costs	
Clearing and grubbing	628
Topsoil removal	1,257
Waste dump under drainage	238
Total Contractor Costs	**2,124**
Total Pre-strip and Mine Pre-production	**15,586**

13.6.3 Pit Dewatering

Water entering the pit will be discharged into the raw water diversion dam. Portable pit dewatering pumps capable of 150 l/s at 110 m total head and associated discharge lines were allowed for in the mining estimate. One of these pumps will be brought to site during the construction phase to dewater the borrow pit if required.

During operations the size of the pit will increase resulting in an increased catchment and ground water inflow potential. Additional pumps were allowed for to cover for this increased inflow as well as the increase in head resulting from deepening of the pit.

13.6.4 Explosives Supply

A bulk manufacturing facility and a mobile manufacturing unit will be supplied by AEL Mining Services East Africa (AEL) at a monthly rental cost.

The proposal is to setup a supply and storage site on the mine from where the bulk explosives service will be managed. The site will consist of a storage facility for chemicals, emulsion manufacturing facility and explosives magazine complex. A maintenance workshop, ablution and change house, offices and magazine will form part of the start-up phase and will be provided by KEFI. Initially, for the first period, one twenty-five tonne Mobile Manufacturing Unit (MMU) will be deployed together with explosives delivery vehicle.

The raw materials will be supplied with Explosives and Initiating systems being sourced from South Africa or Zambia. KEFI will perform the site preparation and the civil construction form part of the construction phase of the mine will be completed by AEL.

13.6.5 Contracting Strategy for Construction

Earthworks Contract:

Plant earthworks are expected to be performed by a local contractor and the contract will be based on a bill of quantities against which quoted rates will be applied.

Civil Works Contract:

Plant civil and building works are to be performed similarly by a local contractor, preferably the same as that contracted for the earthworks. The contract will be based on a bill of quantities against which quoted rates will be applied.

13.7 PROCESS PLANT AND INFRASTRUCTURE CAPEX ESTIMATE

The process plant costs were split into Phase 1 and Phase 2 and are defined as follows:

- Phase 1 - costing of process plant to process ROM ore from Years 1 – 3
- Phase 2 – addition of secondary crushing and screening circuits to accommodate the change in ore type fed to the process plant from Year 4 onwards.

13.7.1 Process Plant and Infrastructure Capital Cost Summary – Phase 1

A summary of the process plant capital cost for Phase 1 is provided in Table 13-6.

Table 13-6: Process Plant Initial Capital Cost Summary

Description	Initial Capital Cost (US$)	Contingency (%)	Initial Capital Cost (Incl. Contingency) (US$)
Process Plant Direct Costs			
Earthworks	4,277,906	20%	5,133,487
Civils	5,318,313	18%	6,275,609
Plant Infrastructure - Buildings	1,051,362	8%	1,135,471
Plant Infrastructure - Civils	793,773	18%	936,652
Structural Steel	1,731,698	10%	1,904,868
Platework (Tanks)	1,641,413	10%	1,805,554
Machinery & Equipment	10,542,769	5%	11,069,907
Piping	1,163,933	20%	1,396,719
Valves	277,953	20%	333,544
Electricals	2,400,174	10%	2,640,191
Instrumentation	1,266,972	8%	1,368,330
Communication and Security	235,670	8%	254,524
Vendor Services	327,114	10%	359,825
Transport	4,624,940	10%	5,087,434
Spares Commissioning	105,933	5%	111,230
Plant First Fills	694,257	5%	728,970
Construction Equipment	3,533,899	10%	3,887,289
SMPP - Construction Labour	2,910,248	10%	3,201,273
Electrical and Instrumentation Installation	1,375,591	10%	1,513,150
Process Plant Direct CAPEX Subtotal	**44,273,918**		**49,144,027**
Process Plant Indirect Costs			
Emergency Power Plant	350,505	7%	375,041
Construction Camp	2,949,275	10%	3,244,203
Plant Overhead Lines	69,581	15%	80,018
Vehicles	800,287	5%	840,301
Mobile Equipment	419,200	5%	440,160
Process Plant Indirect CAPEX Subtotal	**4,588,849**		**4,979,723**
Site Infrastructure			
Site Infrastructure - All Costs	9,648,830	16%	11,183,991
Site Infrastructure CAPEX Subtotal	**9,648,830**		**11,183,991**
Other Costs			
Spares Operational	638,115	5%	670,021
Spares Insurance	701,562	5%	736,640
Other CAPEX Subtotal	**1,339,677**		**1,406,661**
EPCM and Insurances			
EPCM	9,094,247	10%	10,104,719
Insurances	589,346	10%	648,281
EPCM and Insurance CAPEX Subtotal	**9,683,593**		**10,753,000**
Total Process Plant and Infrastructure CAPEX - Phase 1	**69,534,867**		**77,467,402**

13.7.2 Basis of Estimate and Assumptions

The following technical documents form the basis of the capital cost estimate:

- Process plant design criteria
- General layouts of the process plant
- Process flow diagrams
- Process plant equipment list
- Piping and instrument diagrams
- Instrument lists
- Various discipline material take-off documents
- Electrical single line diagrams
- Quotations from vendors on major mechanical and/or process equipment
- Project Implementation Schedule.

The following assumptions have been made in the preparation of this estimate:

- Site work will be continuous and not be constrained by the owner, war, riots, terrorism or political interference.
- The construction schedule will be as presented in Section 12.
- Land within the mine licence and access road areas will be provided encumbrance-free.
- The chosen site will be suitable for the foundations in accordance with the findings of the geotechnical investigation report and no specific problems will arise from excessive precipitation or groundwater, and no rock excavation will be required during excavation.

13.7.3 Process Plant Direct Costs

13.7.3.1 Earthworks and Civils

Estimates of earthworks and civil costs have been determined by bills of quantities derived from general arrangement drawings and material estimates from site layout drawings. Furthermore, average depths, thicknesses and foundation weights appropriate to equipment and, in some areas, quantities from similar jobs have been used as a further guide. The bills of quantities established are based on SANS 1200.

The latest process plant layout was forwarded to the geotechnical engineer at Golder, who made recommendations for soil improvements based on the geotechnical investigations completed for the 2012 DFS layout. The soil improvement requirements have been incorporated into the bills of quantities.

A group of suitable contractors were identified through discussion with Addis Ababa-based project managers and equipment suppliers as well as reference to the Ministry of Urban Development and Construction's List of Registered Contractors. Formal enquiry documentation was prepared and issued to various contractors.

Following a technical and commercial adjudication, an international company working in East Africa was selected as the preferred contractor to complete the earthworks package, and an Ethiopian based company was selected as the preferred contractor to complete the civil works package.

13.7.3.1.1 Construction Materials

Sand

Concrete sand/fine aggregate is available from a local provider, 31 km by road from the plant site. It is not known whether sufficient quantity is available from this source for the civil works requirements. However, this source has been used by the contractor as a price basis. The contractor is fully responsible for the supply of sand.

Stone

A potential gabbro quarry site was identified within the mine licence area. For the purposes of the DFS it is assumed that this source is suitable in quality and quantity for concrete stone/coarse aggregate. KEFI had a sample of this rock analysed by a South African commercial laboratory. None of the physical properties tested proved the stone unsuitable for use in concrete. However, it is recommended that the rock be comprehensively tested, both chemically and petrographically, prior to use in the works.

The contractor will be fully responsible for supplying the stone, and can therefore either allow for the costs of exploitation, crushing, screening and transportation, or allow for the cost of procurement directly from a viable commercial supplier.

Cement

Cement will be supplied by the contractor.

Steel Reinforcement

Steel reinforcement will be supplied by the contractor.

Water

It has been assumed that sufficient construction water will be available on site from existing boreholes and the raw water dam.

13.7.3.2 Infrastructure Buildings

13.7.3.2.1 Civil Works

General arrangement drawings were created for the relevant infrastructure items. The associated civil work was quantified by means of detailed bills of quantities derived from the relevant drawings. A bill of quantities for these works was included in the enquiry document sent out to civil contractors for pricing. The selected contractor (Ethiopian based) provided rates, which included contractor P&G costs. These rates were applied to the final bills of quantities to generate the infrastructure civil works cost estimate.

13.7.3.2.2 Materials

Steel Buildings

General arrangement drawings were sent to various suppliers for pricing. Quotations for the steel buildings include costs for design, supply of material, fabrication and delivery. The quotations received were technically and commercially adjudicated and a preferred vendor was selected.

Prefabricated Buildings

General arrangement drawings were sent to various suppliers for pricing. Quotations for the prefabricated buildings include costs for furniture and equipment, internal finishes, fittings and internal reticulation for water, electricity and sewage. The quotations received were technically and commercially adjudicated and a preferred vendor was selected.

Fence Materials

The quotations received were technically and commercially adjudicated and a preferred vendor was selected.

Pipe Materials

The quotations received for the water and effluent reticulation piping were technically and commercially adjudicated and a preferred vendor was selected.

Equipment and Tools

The quotations received for tools, equipment for use in the plant workshop were technically and commercially adjudicated, and a preferred vendor was selected.

No tools and equipment costs for the mine workshop were allowed for.

13.7.3.3 Structural Steel and Platework

Quantities were established based on material take-offs (MTO's) derived from general arrangement drawings. Quantities from similar projects were used as a further guide. Unit rates based on quotations obtained from fabricators were applied to the MTO's.

The quotes included the following costs:

- Mild steel tanks
- Stainless steel tanks
- Structural steelwork
- Platework
- Liners
- Grating

- Hand railing
- Elution column (S/S)
- Acid wash column and tank (FRP)

13.7.3.4 Machinery and Equipment

Enquiry documentation, which included technical specifications, was prepared for the items on the equipment list and issued to equipment suppliers to provide quotations. The quotations received, in most cases three per equipment type, were technically and commercially adjudicated and a preferred vendor was selected.

13.7.3.5 Piping and Valves

Quantities were based on material take-offs derived from piping and instrumentation drawings (P&IDs) and general arrangement drawings and bench marked against similar projects executed by SENET as a further guide. MTO's for carbon steel, stainless steel, HDPE piping were forwarded to fabricators for pricing.

A valve list compiled from the P&IDs, detailing each manual valve type, was submitted to vendors for pricing. The actuated valve type costs are included in the instrumentation cost estimate.

The quotations received were technically and commercially adjudicated and preferred vendors were selected.

13.7.3.6 Electrical and Instrumentation

13.7.3.6.1 Electrical

Electrical costs were calculated based on the latest PFD's and P&ID's, as well as the most recent equipment lists. Single line diagrams were produced and quantities for electrical equipment derived from that. Actual quotes for the design and supply of the motor control centres were obtained. Estimates for cable racking and plant cabling were based on layout drawings of the respective equipment.

The quotations received were technically and commercially adjudicated to select a preferred vendor.

13.7.3.6.2 Instrumentation

The instrument list was based on the following information:

- PFDs
- P&IDs
- Equipment lists
- Valve lists (actuated)

The PLC and SCADA costs were based on a plant configuration with full plant control from a central control room. Provision has been made for a sequel server for constant data logging and trending, as well as a web server.

Enquiry documents for all instrumentation and PLC & SCADA were issued to vendors and the quotations received were technically and commercially adjudicated to select a preferred vendor.

13.7.3.7 Communications and Security

A scope of work has been established for the systems integration package, which forms part of the process plant and mining infrastructure terrace. This included the supply and installation of computer networks within and between the various infrastructure buildings.

Enquiry documents for the satellite communication system and project security system were issued to vendors and the quotations received were technically and commercially adjudicated to select a preferred vendor.

13.7.3.8 Vendor Services

Certain components of the process plant require the equipment vendor to be in attendance on site during key periods of installation and or commissioning.

Vendor services costs were obtained from vendor quotations and include the costs for vendors required during the construction phase for equipment guarantees. This cost also includes mill installation and commissioning. The vendor services costs include for travel, however accommodation and catering will be provided by the Client.

13.7.3.9 Transport

Total project shipping volumes and weights were established from vendors where possible. Container filling rates (20 foot or 40 foot) were based on historical project data and advice from shipping lines. To reduce total costs, the estimate was calculated using a combination of shipping methods, i.e. appointing dedicated charter vessels, using break-bulk services on offer, and using scheduled containerised vessels travelling to the Port of Djibouti.

Formal enquiries were issued to international freight forwarders. The quotations provided underwent an adjudication process for selection of preferred supplier. This cost was thereafter used for estimation of transport costs.

13.7.3.10 Commissioning Spares

Included in the relevant quotations, vendors of mechanical equipment have provided priced lists for recommended commissioning spares.

These lists have been derived based on the historical experience of each vendor for the relevant item of equipment.

A stores/ warehouse building, located on the mine infrastructure terrace, will be used to house the spare parts and consumables for the process plant and the mining operation.

13.7.3.11 First Fills

The first fill costs were developed from first principles and are defined as those costs incurred prior to commissioning of the process plant. The first fill quantities include the following:

- Grinding media of various sizes for the SAG and ball mills for the design charge levels
- Carbon for use in the leach tanks
- Thermic oil for the elution heat exchangers
- Mechanical equipment lubricants

The first fill costs were generated by applying the rates provided by consumable suppliers to the calculated quantities.

13.7.3.12 Construction Equipment

The construction equipment allowed for the SMPP contract includes the following:

- Mobile equipment
- Major lifting equipment
- Tools and tool boxes
- Welding machines and x-ray costs
- Gas, fuel, raw materials and other consumables
- Communications
- PPE and general site running costs

Formal enquiries were issued to construction equipment suppliers. The quotations provided underwent an adjudication process for selection of preferred supplier. This cost was thereafter used for estimation of construction equipment costs.

13.7.3.13 Structural, Mechanical, Plate-work and Piping (SMPP) Construction Labour

Man-hour schedules were generated from first principles based on equipment and material sizing presented on equipment lists and MTOs. Labour rates sourced from Asian labour brokers have been applied to the man-hour schedules to generate SMPP labour costs.

13.7.3.14 Electrical and Instrumentation (E&I) Installation

Formal enquiries were issued to E&I installation contractors. The quotations provided underwent an adjudication process for selection of preferred contractor. This cost was thereafter used for estimation of E&I installation costs.

13.7.4 Process Plant Indirect Costs

13.7.4.1 Emergency Power Plants

An emergency power plant, comprising three generators, has been allowed for at the process plant. It has been sized to keep certain key process equipment operational (not the complete process plant) when grid power is not available.

A separate emergency power plant comprising one generator has been allowed for on the mining infrastructure terrace. It has been sized to keep all the facilities on the mining infrastructure terrace functional when grid power is not available.

Formal enquiries were issued to reputable generator suppliers. The quotations provided underwent an adjudication process for selection of preferred vendor. This cost was thereafter used for estimation of emergency power plant cost.

13.7.4.2 Construction Camp

A formal enquiry was issued for a fully inclusive 150-man construction camp. Bids received for the camp were technically and commercially adjudicated, and the fully inclusive price from the selected vendor was utilised for the capital cost. Pricing received for the camp included the design, fabrication and installation of all camp facilities, inclusive of all equipment, furniture and services required for the running of the camp.

An experienced catering company was approached to provide a proposal for the management of camp catering and maintenance. A formal quotation has been received and incorporated within the estimate with various provisions made to allow for foreseeable project costs.

13.7.4.3 Overhead Power Lines

Overhead lines will be used to provide power to the raw water dam, TSF, seepage dam, mine village (camp) and mining infrastructure terrace. The overhead lines will be designed and constructed generally in accordance with EEPCo code of practice.

Formal enquiries were issued to reputable overhead power line suppliers. The quotations provided underwent an adjudication process for selection of preferred vendor. This cost was thereafter used for estimation of overhead power line cost.

13.7.4.4 Vehicles

Formal enquiries were issued to vehicle suppliers. The quotations provided underwent an adjudication process for selection of preferred supplier. This cost was thereafter used for estimation of vehicle costs.

13.7.4.4.1 Light Vehicles

The selection of light vehicles below was based on the proposed organogram for process plant and G&A. The following vehicles were allowed for:

- LDV – Hilux Single Cab – 4
- LDV – Hilux Double Cab – 10
- Land Cruiser 200 VX – 1
- Fire Truck – 1
- Ambulance - 1

13.7.4.4.2 Mobile Equipment

The fleet that will form part of the plant and general maintenance heavy vehicles is as follows:

- Telehandler - 1
- Front-End Loader - 1
- 10 t truck with mounted crane - 1
- Skid Steer Loader JC45G – 1
- Crane 30t – 1
- Crane 35t – 1
- Crane 55t – 1
- Crane 250t – 1 (short term hire)
- Cherry Picker – 2
- Extendable Forklift - 1
- Tractor – 1
- Trailer – 1
- Truck with HIAB – 1
- Water Bowser (27m^3) - 2
- Water Bowser (27m^3) – 1
- Diesel Bowser (500l) - 1

13.7.4.4.3 Personnel Transport

The transport listed below will be used to transport personnel from the staff camp to the mine site. Light vehicles will supplement the buses if required.

- Bus - 15 people - 1
- Bus - 60 people – 2

13.7.5 Site Infrastructure

Mining infrastructure costs are shown in Table 13-7 and the basis of the estimate is as per Section 13.7.3 and Section 13.7.4.

Table 13-7: Site Infrastructure Capital Cost Summary

Process Plant CAPEX Item	Initial Capital Cost (US$)	Contingency (%)	Initial Capital Cost (Incl. Contingency) (US$)
Earthworks	4,247,943	20%	5,097,531
Electrical	468,280	10%	515,108
Platework	58,809	10%	64,690
Structural	279,158	10%	307,074
Vendor Services	5,874	10%	6,461
Valves	59	20%	71
Civils	2,197,258	18%	2,592,765
Infrastructure	1,030,776	8%	1,113,238
Mechanical	325,946	5%	342,244
Piping	66,093	20%	79,312
Transport	550,362	10%	605,398
SMPP	418,271	10%	460,098
Total Site Infrastructure Costs	**9,648,829**		**11,183,991**

13.7.6 EPCM and Insurance

13.7.6.1 EPCM

The EPCM estimate was established on a detailed man-hour schedule, per discipline, based on the engineering, procurement, construction and project management work anticipated to reasonably complete the SENET controlled scope of works within the project.

13.7.6.2 Insurance

Insurance has been estimated at 1.0 % of the plant and infrastructure capital costs.

13.7.7 Other Costs

13.7.7.1 Operational and Insurance Spares

Included in the relevant quotations, vendors of mechanical equipment have provided priced lists for recommended spares of the following categories:

- Operating
- Insurance

These lists have been derived based on the historical experience of each vendor for the relevant item of equipment.

A stores/ warehouse building, located on the mine infrastructure terrace, will be used to house the spare parts and consumables for the process plant and the mining operation.

13.7.8 Contingency

The contingency is, by definition, an allowance to cover items required by the scope of works as currently defined but not yet identified, measured or anticipated.

Each discipline within the process plant has been individually considered and an appropriate contingency percentage has been allowed for in each case. Each contingency percentage has been established following a review of the scope definition, level of engineering and details as well as the content of the quotations received to date, and to cater for the risk of unforeseen items, such as rock in excavations, not identified by geotechnical investigation. Table 13-6 to Table 13-8 provide the contingency percentages used for processing plant and site infrastructure capital cost items.

13.7.9 Process Plant and Infrastructure Capital Cost Summary – Phase 2

A summary of the process plant capital cost for Phase 2 is summarised in Table 13-8.

Table 13-8: Process Plant Sustaining Capital Cost Summary

Process Plant CAPEX Item	Sustaining Capital Cost (US$)	Contingency (%)	Sustaining Capital Cost (including Contingency) (US$)
Process Plant Direct Costs			
Civils	120,171	18%	141,801
Structural Steel	368,715	10%	405,586
Platework (Tanks)	134,138	10%	147,552
Machinery & Equipment	514,447	5%	540,170
Vendor Services	45,113	10%	49,624
Transport	466,895	10%	513,585
Spares Commissioning	385	5%	404
SMPP Construction Labour	264,402	10%	290,842
Process Plant Direct CAPEX Subtotal	**1,914,266**		**2,089,564**
Other Costs			
Insurance	20,023	10%	22,026
Spares Operational	47,073	5%	49,427
Spares Insurance	40,988	5%	43,038
Other CAPEX Subtotal	**108,085**		**114,490**
Total Process Plant and Infrastructure Sustaining CAPEX	**2,022,351**		**2,204,055**

The basis used to develop the capital cost for Phase 2 was the same as that used for Phase 1. The EPCM costs for Phase 2 have been excluded from this study as this was considered deferred capital.

13.8 TAILINGS STORAGE FACILITY (TSF)

Summaries of the estimates of capital costs for the phased development of the TSF over the life of mine of 13 years are presented in Table 13-9 and Table 13-10 inclusive of provisions for contractor's preliminary and general costs at 25% of the value of the measured works. It is estimated that the initial capital cost of establishing the Tulu Kapi TSF is $8.186 million, which includes the Phase 1A works and approximately half of the Phase 1B works. The on-going development of the TSF would require the expenditure of $15.703 million over the remaining project life.

Table 13-9: Summary of Estimated Capital Expenditure – Tulu Kapi TSF Construction

Description	Phase 1A (US$,000)	Phase1B (US$,000)	Phase 2 (US$,000)	Phase 3 (US$,000)	Phase 4 (US$,000)	Total (US$,000)
Site Clearance and Topsoil Stripping	421	265	364	752	111	1,914
Construction of Starter Embankment and Containment Walls	815	1,217	2,143	6,944	34	11,155
Starter Embankment and Containment Wall Drainage	966	54	0	0	0	1,021
Temporary Penstock Decant System	1,812	0	0	0	0	1,812
Seepage Collection and Sediment Control	332	61	74	21	21	509
Post Closure Decant System	12	0	0	39	119	171
Miscellaneous	652	0	0	0	0	652
Sub-Total : Measured Works	**5,012**	**1,598**	**2,581**	**7,757**	**286**	**17,234**
Design & Engineering	197	0	0	0	0	197
Contractor's Preliminary and General Costs	1,253	399	645	1,939	71	4,307
Contingencies	626	199	322	969	35	2,154
TOTAL COST	**7,088**	**2,196**	**3,548**	**10,665**	**392**	**23,889**

Table 13-10: TSF Capital Expenditure by Phase

Description	Initial Capital Cost (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl Contingency) (US$,000)	Sustaining Capital Cost (US$,000)	Total Capital Cost (US$,000)
Phase 1A	6,265	626	6,891	0	6,891
Phase 1B	999	99	1,098	1,098	2,196
Phase 2	0	0	0	3,548	3,548
Phase 3	0	0	0	10,665	10,665
Phase 4	0	0	0	392	392
Design & Engineering	197	0	197	0	197
Totals	**7,461**	**725**	**8,186**	**15,703**	**23,889**

Both the initial and on-going capital expenditure are dominated by the cost of constructing the downstream wall lifts to the TSF containment wall. It must be noted that the estimates of those costs exclude the cost of sourcing the necessary materials, which is assumed will be supplied to the site of the wall free of charge by the mining contractor.

13.9 PUMPING AND PIPING FOR TSF AND RAW WATER

The design of the return water and pumping systems is described in Annexure 7.3 contains the design and cost estimate for the TSF return water management at a cost of $1.239 million.

Table 13-11: TSF Slurry Delivery and Return System

Description	Initial Capital Costs (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl. Contingency) (US$,000)
Return Water Pumping System	307	46	353
Raw Water Pumping System	318	48	365
Northern Slurry Pumping System	426	64	490
Southern Section Slurry System	26	4	30
	1,077	**162**	**1,239**

13.10 RAW WATER STORAGE FACILITY AND ASSOCIATED PUMPING AN PIPING

The estimate for the raw water diversion dam is for it to be constructed during TSF Phase 1A construction. The detailed cost work up can be found Annexure 7.1 Tulu Kapi Gold Project Updated DFS Design of Tailings Storage Facility: Schedule G. Total cost of the raw water diversion dam, infrastructure and spillway is $3.827 million.

Table 13-12: Raw Water Delivery System

Description	Initial Capital Costs (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl. Contingency) (US$,000)
Raw Water Dam Construction	2,343	234	2,577
Associated Infrastructure & Engineering	450	50	500
Spillway	675	75	750
Total	**3,468**	**359**	**3,827**

13.11 OFF-SITE INFRASTRUCTURE

Off-site infrastructure is those projects that are outside the general location of minesite operations, this includes the mine village, the power line and infrastructure connection to the national power grid and the access road from the highway to the minesite.

Table 13-13: Off-site Infrastructure

Description	Initial Capital Costs (US$,000)	Contingency (US$,000)	Initial Capital Cost (Incl. Contingency) (US$,000)
Overhead Power lines	10,528	1,053	11,581
Village (incl. consultants fees)	3,200	320	3,520
Access & Bypass Roads	7,000	700	7,700
Infrastructure -Total	**20,728**	**2,073**	**22,801**

13.11.1 Overhead Power Lines

The costs developed for the 47km overhead power line connecting the mine site to the Ethiopian power grid are from Annexure 10.7 and independent study by Lord Consulting Engineers and is a quote from a preferred supplier. The quote of $11.581 million (including 10% contingency) includes supply, construction, design and supervision along with environmental costs.

13.11.2 Village

The 232 man KEFI Village includes the cost of construction and associated infrastructure including the furniture and fittings. Total cost estimate is $3.52 million, (includes contingency and engineering), for the construction of the camp are developed in Annexure 10.4.

13.11.3 Access Roads outside the Mining Concession

The 14kms of roads 9.5km site access and 4.5km of concession bypass roads. The cost of constructing these roads is including in the initial capital costs except for the northern bypass road which is built later and included in sustaining capital costs.

The roads have been designed as an unpaved Design Class DS5 road for Mountainous Terrain in accordance with the Ethiopian Roads Authority's Design Manual for Low Volume Roads. The estimated cost for roads is $7.7 million as developed in Annexure 10.2.

13.12 OWNER'S COSTS AND WORKING CAPITAL

13.12.1 Owner's Costs

From the initiation of the project up to the commencement of processing operations, the operating costs incurred by the project are included in the capital cost estimate.

Table 13-14: Owners Costs and Working Capital

Description	Initial Capital Costs (US$,000)
Owners Costs	
Construction Management Labour	1,040
G&A Labour	1,111
Mining Labour & Maintenance	831
Processing Labour & Maintenance	606
Assay Laboratory (Mining + Process)	1,047
Camp Food and Catering Costs	77
Maintenance	67
Off-site Offices & Travel	721
Supplies & Spare Parts	540
Other Admin Costs	314
Training	2,500
Sub Total Owners Costs	**8,854**
Working Capital	**5,481**
Total	**14,303**

Owner's pre-productions costs comprise the following:

- General and administration salaries, including owner's project team, HSSE department finance, procurement and human resources
- Mining department labour costs prior to commencement of pre-strip
- Plant labour costs prior to commencement of plant commissioning
- Costs associated with the administration of an off-site office in Addis Ababa
- Camp catering costs
- Training package implementation and contractor engagement
- Preparations for contractor managed and operated onsite laboratory
- Vehicle running and maintenance costs
- The cost of other administrative support

13.12.2 Working Capital

The working capital buffer included in initial capital expenditure has been estimated at $5.481 million. This estimate provides for the first two months of operating costs.

13.13 RELOCATION AND RESETTLEMENT

The development of the Tulu Kapi Gold Mine will require relocation of some local residents. To provide for crop compensation, property compensation, relocation, infrastructure and livelihood re-establishment $7.5 million has been allocated based on quotations, baseline studies and information available from the Ethiopian federal statistics on crop yields and market price.

An additional $1.245 million has been provided to assist the community restoring their livelihoods after resettlement.

Table 13-15: Relocation and Resettlement Costs

Description	Initial Capital Costs (US$,000)	Sustaining Capital Costs (US$,000)	Total Capital Costs (US$,000)
Relocation, Resettlement	7,000	500	7,500
Livelihood Restoration	415	830	1,245
Total	**7,415**	**1,330**	**8,745**

13.14 ENVIRONMENTAL MANAGEMENT

A provision has been made to further develop our Environmental Management capacity by the continuing development of our management plans prior to production. An allocation of $0.525 million to develop the four plans listed in Table 13-16.

Table 13-16: Environmental Management Costs

Description	Initial Capital Costs (US$,000)
Ground Water Characterisation	200
Waste Management Plan	100
Air Quality Plan	125
Noise and Vibration Monitoring Plan	100
Total	**525**

13.15 CLOSURE

The closure cost considers the cost of ongoing rehabilitation during the mining operations as well as the cost of closing the TSF and rehabilitation of the site.

Table 13-17: Closure Costs

Description	Closure Costs (US$,000)	Contingency (US$,000)	Closure Costs (Incl. Contingency) (US$,000)
TSF Closure	7,840	1,050	8,890
Mine Waste Dump Closure	1,320	0	1,320
Site Clean Up	1,210	0	1,210
Equipment	443	0	443
Total	**10,813**	**1,050**	**11,863**

The closure plan has been broken into four cost elements, TSF closure (Annexure 7-1), waste dump, general site clean-up and a provision for equipment and suppliers to assist in the overall closure. The total provision is $11.863 million.

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SECTION 14 Operating Cost Estimate

Tulu Kapi Gold Project
Definitive Feasibility Study
July 2015

Golder Associates

epoch resources (pty) ltd

SNOWDEN

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Scoping Studies | Prefeasibility Studies | Feasibility Studies | Engineering | Procurement and Logistics | Construction Management | Commissioning

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14.1 INTRODUCTION

The purpose of the operating cost estimate (OPEX) is to provide costs that will be utilised to assess the economics of the Tulu Kapi Project. The level of accuracy of the OPEX is -10% +15% of the overall project costs as of Q1 2015 and does not include any escalation factors.

14.2 SCOPE OF THE ESTIMATE

The OPEX has been developed for a conventional open-pit mining operation, CIL process plant, tailings storage and support infrastructure capable of treating 1.2 Mtpa.

14.3 RESPONSIBILITIES

The operating costs were developed as follows:

- Mining – Snowden
- Process plant and assay laboratory – SENET
- General and administration – SENET and KEFI
- Tailings Storage Facility – Epoch
- Environmental, social infrastructure and closure - Golder

14.4 EXCHANGE RATES

The cost estimates are provided in US Dollars (US$). The exchange rates used are as per Section 13, Table 13-1.

14.5 TAXES AND DUTIES

All operating cost estimates compiled for this DFS have been done so on the basis that the project is tax and duty exempt.

The costs for all imported consumables are exclusive of import duties.

14.6 OPERATING COST SUMMARY

Table 14-1 provides a summary of the overall LOM operating cost estimate.

Table 14-1: Operating Cost Estimate Summary

Operating Costs ('1000US$)	Yr 1	Yr 2	Yr 3	Yr 4	Yr 5	Yr 6	Yr 7	Yr 8	Yr 9	Yr 10	Yr 11	Yr 12	Yr 13	Yr 14	LOM
Mining	25 695	33 089	40 508	42 154	44 238	44 383	41 450	27 310	18 713	12 931	5 011	3 500	3 416	1 046	**343 489**
Milling - Oxide	2 987	436	217	190	-	194	-	-	144	1 381	25	-	2 618	-	**8 193**
Milling - Fresh	6 101	8 465	8 615	8 256	9 079	6 449	2 227	1 626	5 188	6 027	8 378	9 359	714	-	**80 520**
Milling - Hard Fresh	-	-	-	924	-	3 272	8 739	9 473	5 279	3 051	1 321	-	7 618		**39 677**
Site G&A	7,137	7,137	7,137	7,137	7,137	7,137	7,137	7,137	7,137	7,137	4,461	3,568	3,568	-	**82,966**
Total Operating Cost	41 920	49 127	56 477	58 661	60 454	61 435	59 553	45 546	36 461	30 527	19 196	16 463	17 934	1 046	**554 800**

14.7 MINING OPERATING COSTS

The total mine operating costs, based on an owner operated scenario, was estimated to be $359 million for the life of mine, including $15.6 million of pre-production costs. Based on a total material movement of 134 million tonnes the unit operating cost was estimated to be $2.68 per tonne. This compares to the 2014 preliminary owner cost estimate by Snowden of $2.79 and is therefore within 5% of the previous estimate that also allowed for new equipment. Figure 14-1 provides a summary of the distribution of mine operating costs over the life of mine.

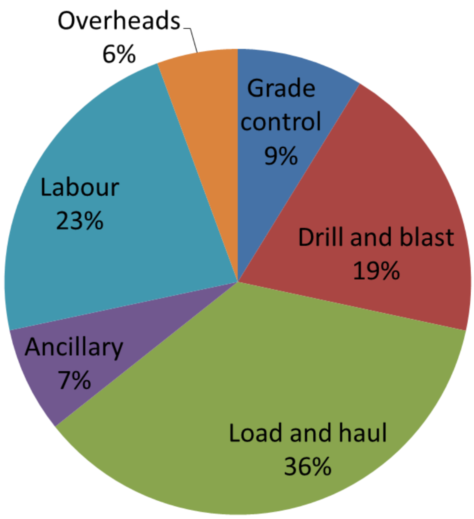

Figure 14-1: Distribution of Mine operating costs

Reallocation of $15.6 million in preproduction costs into the capital development classification reduced the unit operating to $2.56 per tonne.

The overall development of the costs are summarised in Table 14-2 with the operation of the plant and ancillary equipment the largest of the cost areas. A bottom up, first principles approach was used as the basis of estimating the operating costs for the open pit mining operations. The costs were compiled from a variety of sources including:

- Labour salary survey by Meyer Hoskings for the Tulu Kapi project
- OEM budget quotations for the project for major and ancillary equipment;
- Contract and vendor quotations specific to the project;
- Non-specific vendor quotes
- Senet cost estimates applicable equipment and services
- Contractor costing quoted by third party consultants
- Database costs for similar projects

Table 14-2: Mine Operating Cost Summary

Mine Operating Cost	Cost/Mined Tonne (US$)
Mining Plant Operating Cost	1.43
Mining Materials Cost	0.52
Mining Labour Cost	0.49
Mining Overheads	0.21
Mining Contractor Costs	0.04
Total Mine Operating Cost	**2.68**

14.7.1 Mining Plant Operating Costs

The cost of the of the mining plant is broken down in detail with the primary fleet being the predominant cost driver at 78% of the cost, the ancillary fleet is in direct support of the primary fleet. The cost includes fuel, lubricants, spares, tyres, ground engaging tools and general maintenance. The cost of onsite labour for operator and maintenance was estimated separately. Fuel will be dispensed from a facility owned by the fuel supply contractor at a cost of $0.84 per litre.

The operating cost also reflects the production rate estimates. A conservative operating efficiency was applied the form of a 50 minute operating hour. Mine haulage allows for loading operations to be over trucked, resulting in cueing of trucks, to ensure excavator production rates can be maximised. Ancillary fleet were determined from typical factors applied to loading operations.

Table 14-3: Mining Plant operating Costs

Mining Plant Operating Cost	Cost/Hr Exc Lab (US$)	Cost/Mined Tonne (US$)
Primary fleet		
Digger 200 t	310	0.23
Digger 120 t	236	0.05
Truck 90t	168	0.66
Blast hole drilling	172	0.07
RC drilling	197	0.11
Ancillary fleet		
Track dozer	120	0.06
Wheel dozer	144	0.03
Grader	65	0.03
Watercart	79	0.04
Batter digger	126	0.01
Rock breaker	135	0.00
Stemming Truck	80	0.01
Lighting towers	5	0.01
Fuel and lube truck	75	0.01
Minor Equipment		
IT tool carrier with forks	58	0.01
Tyre handler	58	0.01
Backhoe	36	0.00
Skidsteer loader	26	0.00
Standpipe	15	0.00
Mobile workshop crane 25t	64	0.00
Dewatering pumps	83	0.04
Light vehicles		
Single Cab Utes	37	0.03
Twin Cab Utes	29	0.01
Land cruiser	52	0.01
Coaster Bus	27	0.01
Total Plant Operating Cost		**1.43**

14.7.2 Mining Materials Cost

The majority of the mining consumables after mining plant are in the area of drill and blast. The costs for explosives have been calculated using first principles and supplier quotations and information from AEL. The price is for the cost of explosive, the down hole service contract costs are covered under mining overheads. The other consumables are for grade control and blast hole drilling. There is also a provision for the crushing of road base and stemming materials.

Materials associate with the operation of the machine such as diesel, tyres and ground engaging tools are covered under the operating cost of the machine.

Table 14-4: Mining Materials Cost

Mining Materials Cost	Cost/Mined Tonne (US$)
Prod Drilling Consumables	0.02
RC Drilling Consumables	0.10
Explosives	0.38
Road base	0.02
Materials Operating Cost	**0.52**

14.7.3 Mining Labour Cost

The manpower requirement has been developed by Mining And Cost Engineering Pty Ltd. The salaries and on costs for both expatriate and national labour were derived from bench mark studies of African mines and Ethiopian Industry. Mine operations and mine maintenance costs allow coverage for absentee rates of up to 30% per person, on average.

Table 14-5: Mining Labour Cost

Mining Labour Cost	Cost/Mined Tonne (US$)
Mining Management	0.04
Mine Technical Service Dept	0.10
Mine Operations	0.21
Mine Maintenance	0.14
Total Labour Cost	**0.49**

14.7.4 Mining Overheads and contractor cost

Mining overheads allow for fixed costs associated with the project and costs not covered elsewhere.

Table 14-6: Mining Overheads Cost

Mining Overheads Cost	Cost/Mined Tonne (US$)
Explosive in hole delivery	0.07
Grade Control (assay and cons)	0.02
Tech support and training	0.05
General mining expenses	0.05
Mine Workshop	0.01
Total Mining Overheads	**0.20**

Contractor costs cover the costs for preparing the ground for excavation of waste rock disposal. Cost cover contractor rates however this work could be carried out on an owner operator basis.

Table 14-7: Mining Contractor Costs

Contractor Costs	Cost/Mined Tonne (US$)
Clearing and grubbing	0.01
Topsoil removal	0.02
Waste dump underdrainage	0.01
Total Contractor Costs	**0.04**

14.8 PROCESSING PLANT AND ASSAY LABORATORY OPERATING COSTS

14.8.1 Scope of the Estimate

The OPEX was developed for the following ore types:

- Oxide/Saprolite
- Shallow Fresh
- Deep Hard Fresh

14.8.2 Basis of Estimate

The processing plant operating costs were compiled from a variety of sources:

- First principles, where applicable
- Supplier quotations on reagents and consumables
- SENET's in-house database

- Client input

The following are the main cost elements of the process plant:

- Reagents and consumables
- Power
- Process plant operating and maintenance labour
- Maintenance, parts and supplies
- Assay laboratory

14.8.3 Summary of Processing Plant Operating Costs by Ore Type

The operating costs were developed by ore type for the following reasons:

- The comminution characteristics were different for the various ore types, hence the milling power requirements varied by ore type.
- Testwork showed that the reagents consumptions varied by ore type.

The operating costs are summarised in Table 14-8.

Table 14-8: Processing Plant OPEX by Ore Type

Opex Item	Unit	Ore Type		
		Oxide	Shallow Fresh	Deep Fresh
Consumables	US$/tore	6.88	4.49	6.38
Power	US$/tore	0.60	0.64	0.73
Labour	US$/tore	1.74	1.74	1.74
Maintenance, Parts & Supplies	US$/tore	0.63	0.63	0.63
Total Process Plant Opex	**US$/tore**	**9.86**	**7.50**	**9.48**
Assay (Process & Mining)	US$/tore	0.12	0.12	0.12
Total Process Plant Opex +Assay	**US$/tore**	**9.98**	**7.63**	**9.60**

14.8.4 Summary of Life of Mine Processing Plant Operating Costs

The mine schedule provided by the Client was used as the basis to calculate the LOM processing plant operating costs. The schedule provides the proportions of each ore type to be treated in each year. By using this, the weighted consumptions for each operating cost item were calculated. The LOM processing schedule and the LOM processing plant operating costs are shown in Table 14-9 and Table 14-10.

Table 14-9: LOM Processing Schedule – Physicals

	Period (Yr)	-1	1	2	3	4	5	6	7	8	9	10	11	12	13
Process															
Saprolite (kt)	937		362	59	29	24	0	23			16	158	3	0	261
- Grade – Au (g/t)	1.56		2.08	2.93	2.70	1.59	1.33	1.40			1.15	1.13	1.05	0.75	0.70
Fresh (kt)	10,091		738	1,141	1,171	1,057	1,200	781	244	176	587	691	1,034	1,200	71
- Grade – Au (g/t)	1.99		1.92	3.46	2.98	2.17	2.83	2.16	3.01	1.16	1.08	1.00	0.73	0.69	0.67
Hard Fresh (kt)	4,365					118		396	956	1,024	597	350	163		761
- Grade – Au (g/t)	2.54					3.82		3.09	2.80	2.95	3.54	2.60	0.95		0.70
Total (kt)	15,393		1,100	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,200	1,093
- Grade – Au (g/t)	2.12		1.97	3.44	2.97	2.32	2.83	2.45	2.84	2.68	2.30	1.48	0.76	0.69	0.70
Metal															
Mined - Au (koz)	1,047	4	83	191	136	76	129	95	129	104	68	29	1		
Feed - Au (koz)	1,050		70	133	115	90	109	95	110	104	89	57	29	27	25
Recovered - Au (koz)	960		65	123	106	82	101	86	99	93	80	52	26	24	22

Table 14-10: LOM Processing Plant & Assay OPEX

OPEX Item	Unit	Overall LOM	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13
Reagents and Consumables	US$/t ore	5.17	5.28	4.61	4.55	4.73	4.49	5.16	5.99	6.10	5.46	5.36	4.75	4.49	6.38
Power	US$/t ore	0.66	0.63	0.64	0.64	0.65	0.64	0.67	0.71	0.71	0.68	0.66	0.65	0.64	0.69
Labour	US$/t ore	1.77	1.90	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.74	1.91
Maintenance, Parts and Supplies	US$/t ore	0.62	0.33	0.31	0.31	0.57	0.57	0.57	0.57	0.57	0.83	0.83	0.83	0.83	0.91
Total Process Plant OPEX	**US$/t ore**	**8.22**	**8.14**	**7.29**	**7.24**	**7.69**	**7.44**	**8.14**	**9.02**	**9.13**	**8.72**	**8.59**	**7.98**	**7.71**	**9.89**
Assay – Process plant and Mining	US$/t ore	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12
Total Processing Plant & Assay OPEX	**US$/t ore**	**8.34**	**8.26**	**7.42**	**7.36**	**7.81**	**7.57**	**8.26**	**9.14**	**9.25**	**8.84**	**8.72**	**8.10**	**7.83**	**10.02**

14.8.5 Reagents and Consumables

The plant reagents and consumables costs were derived using the methods that are given below and detailed in Table 14-11 to Table 14-13.

14.8.5.1 Crusher and Mill Liners

Crusher and mill liner costs were obtained by estimating the number of liner changes per annum using the crusher and mill liner wear life modelled by OMC. Quotations for the liners, including the weights of the liners, were obtained from the crusher and mill vendors, from which delivered costs were estimated per liner set.

14.8.5.2 SAG and Ball Mill Grinding Media

SAG and ball mill grinding media consumptions were determined by using the consumption rates modelled by OMC. Quotations from grinding media suppliers and the consumptions were used to calculate the grinding media costs.

14.8.5.3 Cyanide

The cyanide LOM cost was estimated from the total cyanide consumption in the CIL leaching of oxide, shallow fresh and deep hard fresh ore samples. The LOM cost also includes the cyanide consumption associated with elution, which was calculated from first principles (taking into account the designed number of elutions and the expected cyanide strength in the eluant). The total cyanide consumption in these two areas over a given period was weighted and, together with quotations obtained from suppliers, an estimate of the LOM cyanide costs was determined.

14.8.5.4 Lime

The LOM cost for lime was estimated from lime consumptions in the CIL and detoxification circuits achieved from test work that was performed on each ore type. The weighted consumption and quotations obtained from suppliers were then used to estimate the LOM lime costs.

14.8.5.5 Copper Sulphate ($CuSO_4$) and Sodium Metabisulphite ($Na_2S_2O_5$)

For the purpose of cyanide destruction, $CuSO_4$ and $Na_2S_2O_5$ will be used and consumptions of both were estimated from testwork results and adjusted to reflect the partial cyanide destruction taking place in the plant tails slurry from 100 ppm to 50 ppm. Quotations obtained from suppliers were then used, together with the consumption, to estimate the LOM $CuSO_4$ and $Na_2S_2O_5$ costs.

14.8.5.6 Carbon

Carbon consumption of 25 g/t was used and was based on industry practice for CIL plants. Quotations obtained from suppliers were then used, together with the consumption, to estimate the carbon costs per annum for a given throughput.

14.8.5.7 Caustic

Caustic consumption associated with elution/electrowinning was calculated from first principles taking into account the following parameters:

- Designed number of elutions
- Expected caustic strength in the solution

Quotations obtained from suppliers were then used, together with the consumption, to estimate the LOM caustic costs.

14.8.5.8 Hydrochloric Acid

Hydrochloric acid required for acid washing was calculated from first principles taking into account the following:

- Designed number of acid washes
- Expected acid strength in the solution

Quotations obtained from suppliers and the consumption were then used, together with the consumption, to estimate the LOM hydrochloric acid costs.

14.8.5.9 Smelting Reagents

Reagent consumptions associated with smelting (used as fluxes) were calculated from first principles taking into account the designed number of smelts and the flux composition (as per industry practice). Quotations obtained from suppliers, together with the consumption, were then used to estimate the LOM smelting reagents costs.

Table 14-11: Reagents and Grinding Media Costs

Reagent/ Consumable	Delivered Form			Cost to Djibouti (US$/t)	Cost from Djibouti to Site (US$/t)	Delivered Cost (US$/t)
	Method/Size	Formula	% Strength/Size			
Hydrated Lime	1 000 kg/bag	$Ca(OH)_2$	75 %	245	298	543
Copper Sulphate	25 kg/bag	$CuSO_4.5H_2O$	98 %	2 085	298	2 383
SMBS (Sodium Metabisulphite)	25 kg/bag	$Na_2S_2O_5$	98 %	425	298	723
Activated Carbon	1 000 kg/bag	C	8 × 16 mesh	2 350	298	2 648
Hydrochloric Acid	200 kg/drum	HCl	93 %	328	298	626
Antiscalant (sulphamic acid)	200 kg/drum	H_3NSO_3	-	1 910	298	2 208
Caustic Soda	25 kg/bag	NaOH	-	515	298	813
Borax	25 kg/bag	$Na_2B_4O_7.10H_2O$	-	3 109	298	3 406
Silica	25 kg/bag	SiO_2	-	322	298	619
Sodium Carbonate	25 kg/bag	Na_2O_3	-	679	298	977
Sodium Cyanide (CIL)	1 000 kg/box	NaCN	99 %	2 000	298	2 298
Steel Grinding Balls	900 kg/drum	Forged	125 mm	850	298	1 148
Steel Grinding Balls	900 kg/drum	Medium Chrome	65 mm	998	298	1 296

Table 14-12: Liner Costs

Liners	Mass/set (t)	Cost/Set (US$)
Primary Crusher	7.74	40 965
Secondary Crusher	2.09	17 062
SAG Mill	30	505 000
Ball Mill	20	316 009

Table 14-13: Reagents and Consumables Consumptions

Reagent/Consumable	Consumption (g/t)		
	Oxide	Shallow Fresh	Deep Fresh
Hydrated Lime	5 852	1 088	931
Copper Sulphate	77	77	77
Sodium Metabisulphite	842	842	842
Activated Carbon (8 × 16 mesh)	25	25	25
Hydrochloric Acid	65	65	65
Antiscalant (sulphamic acid)	20	20	20
Caustic Soda	62	69	69
Borax	1.44	1.44	1.44
Silica	0.72	0.72	0.72
Sodium Carbonate	0.72	0.72	0.72
Sodium Cyanide – CIL	325	129	153
Liners - Primary Crusher	29	36	67
Liners - Secondary Crusher	0	0	14
Liners - SAG Mill	17	47	106
Liners - Ball Mill	108	113	159
Grinding Media - SAG Mill	53	289	673
Grinding Media - Ball Mill	829	875	1 263

The LOM reagents and consumables costs per item are shown in Table 14-14. These costs are calculated using the weighted consumptions based on the proportions of the ore types treated in each year according to the mine schedule that was provided by the Client.

Table 14-14: Reagents and Consumables LOM Costs

Reagent/Consumable	Unit	Overall LOM	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11
Liners - Primary Crusher	US$/t	0.12	0.09	0.12	0.12	0.13	0.13	0.13	0.17	0.19	0.19	0.16	0.12
Liners - Secondary Crusher	US$/t	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13
Liners - SAG Mill	US$/t	0.53	0.29	0.39	0.40	0.43	0.42	0.46	0.67	0.81	0.81	0.63	0.43
Liners - Ball Mill	US$/t	0.70	0.62	0.63	0.63	0.64	0.64	0.66	0.76	0.84	0.83	0.75	0.65
Grinding Media - SAG Mill	US$/t	0.44	0.22	0.31	0.32	0.35	0.35	0.38	0.56	0.69	0.68	0.53	0.34
Grinding Media - Ball Mill	US$/t	1.27	1.11	1.13	1.13	1.16	1.15	1.19	1.40	1.54	1.53	1.36	1.18
Lime	US$/t	0.71	1.70	0.77	0.69	0.65	0.61	0.60	0.56	0.56	0.52	0.61	0.91
Sodium Cyanide	US$/t	0.34	0.49	0.33	0.31	0.31	0.30	0.31	0.33	0.35	0.34	0.33	0.36
Copper Sulphate	US$/t	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Sodium Metabisulphite	US$/t	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61	0.61
Activated Carbon (8 × 16 mesh)	US$/t	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
Hydrochloric Acid	US$/t	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Antiscalant	US$/t	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Caustic Soda	US$/t	0.06	0.05	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06
Borax	US$/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Silica	US$/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sodium Carbonate	US$/t	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

14.8.6 Power

Operating fixed power was determined by applying a load factor to the installed power supplied by vendors. This excluded standby equipment power. Where vendors did not supply operating power, an assumed factor was used to calculate the operating power. The estimated operating hours for the mechanical equipment were determined and used with the operating power to determine the annual power usage (kWh/a).

Operating variable power for the SAG and ball mills was determined using the specific energy of the oxide, shallow fresh and deep fresh ore types, which was modelled by OMC. The specific energy of each mill was used with the mill throughput to calculate the annual power usage (kWh/a).

A power draw summary and power cost per ore type were determined using the power consumption basis detailed above and a power cost of US$0.02/kWh which was supplied by the Client.

Refer to Table 14-15 for the power draw summary and cost by ore type.

Table 14-15: Power Draw Summary and Cost

Item	Unit	Oxide	Shallow Fresh	Deep Fresh
Fixed Power				
Fixed Power Consumption per annum	kWh/a	15 419 898	15 419 898	15 665 952
Fixed Power Consumption per tonne ore	kWh/t	12.8	12.8	13.1
Variable Power -SAG and Ball Mill				
Specific Energy	kWh/t	17.2	19.1	23.2
Variable Power Consumption	kWh/a	20 665 574	22 920 000	27 840 000
Total Power	kWh/a	36 085 471	38 339 898	43 505 952
Power Cost	US$/kWh	0.02	0.02	0.02
Total Power Cost per annum	US$/a	721 709	766 798	870 119
Total Power Cost	**US$/t ore**	**0.60**	**0.64**	**0.73**

Table 14-16 below shows the detailed fixed power draw for each plant area by ore type.

Table 14-16: Fixed Power Draw

Plant Area	Oxide and Shallow Fresh Fixed Power			Deep Fresh Fixed Power		
	Installed Power (kW)	Operating Power (kW)	Power Draw (kWh/a)	Installed Power (kW)	Operating Power (kW)	Power Draw (kWh/a)
AREA 2200: CRUSHING	309	193	982 773	373	427	1 228 827
AREA 2400: MILL FEED STOCKPILE	27	23	186 400	27	23	186 400
AREA 3100: MILLING CIRCUIT	580	252	908 094	580	252	908 094
AREA 3500: TRASH HANDLING	6	5	43 520	6	5	43 520
AREA 4100: CIL	426	923	4 259 427	426	923	4 259 427
AREA 5100: DETOXIFICATION	125	105	742 454	125	105	742 454
AREA 6100: ACID WASH	7	5	591	7	5	591
AREA 6200: ELUTION	928	829	1 370 909	928	829	1 370 909
AREA 6300: ELECTROWINNING - CIL	46	31	118 549	46	31	118 549
AREA 6400: REGENERATION	444	397	2 896 567	444	397	2 896 567
AREA 6500: GOLD ROOM	97	71	259 629	97	71	259 629
AREA 7100: CYANIDE AND CAUSTIC	26	10	26 486	26	10	26 486
AREA 7200: LIME	54	30	145 060	54	30	145 060
AREA 7400: DETOXIFICATION REAGENTS	13	7	12 944	13	7	12 944
AREA 8100: COMPRESSED AIR	237	153	1 123 040	237	153	1 123 040
AREA 8400: PROCESS WATER	126	59	556 493	126	59	556 493
AREA 8500: RAW WATER - RAW WATER SUPPLY AND DISTRIBUTION	202	122	255 666	202	122	255 666
Plant Infrastructure	266	191	1 531 296	266	191	1 531 296
Total (Excluding Mills)	**3 917**	**3 407**	**15 419 898**	**3 980**	**3 641**	**15 665 952**

14.8.7 Process Plant and Maintenance Labour

Process plant and maintenance labour is comprised of expatriates, national and local labour. The expatriate labour category refers to labour sourced outside of Ethiopia.This category is split into two types; expatriates 1 who are sourced from USA, Europe, RSA and Australia, expatriate 2 who are sourced from Asia and West Africa. National labour refers to labour sourced from Ethiopia but not within the mine locale. Local labour is sourced from the communities close to the mine. The labour total costs to company were determined using the basis described below.

The process plant expatriate labour cost includes the following:

- Labour remuneration
- Ethiopia in-country taxation

- Vacation/sick leave
- GPA and illness insurance
- Social insurance
- Airfares
- Social security

The process plant national and local labour cost includes the following:

- Labour remuneration
- Ethiopia in-country taxation
- 13th cheque
- Vacation/sick leave
- GPA and illness insurance
- Social insurance
- Social security

The following costs have been excluded as they have been included in the G&A operating costs:

- Camp food and catering costs
- Safety supplies costs
- Training costs
- Consultants' fees

Process plant operators and supervisory staff will work on a 3 × 8-hour shift per day, 7 days a week. Technical and maintenance staff for the process plant will work day shifts only. Technical and maintenance staff will be on standby after hours on a rotational basis.

Management, and G&A staff will work on a 1 × 8-hour shift per day, 5 days a week. Expatriates and national labour will be expected to work on a 6 weeks on and 2 weeks off cycle. During the 6 weeks on duty, the expatriates and national labour will reside in the camp facility on site. During the 2 weeks off, they will have the opportunity to return to their country/town of permanent residence, after which they will return to commence the next 6 weeks on duty.

The expatriate labour rates are based on rates that have been benchmarked against mines already operating in Africa and North America. The national and local labour rates are based on existing KEFI rates, technical rates in the marketplace, and comparisons done based on the experience required to fill roles that are not common in Ethiopia.

The labour cost summary by category is shown in Table 14-17 below and the detailed cost breakdown for the plant operations and maintenance labour are shown in Table 14-18.

The Patterson grading method was used for the job grading exercise. Employees are graded according to salary scale ranging from Level A1 (lowest paid, typically labourers) to level E (highest paid, typically senior management)

Table 14-17: Labour Cost Summary

Category	Total Plant Labour		Plant Operations Labour		Plant Maintenance Labour	
	No. of People	Cost (US$)	No. of People	Cost (US$)	No. of People	Cost (US$)
Expatriates	4	499 925	3	397 013	1	102 912
Nationals	70	1 092 069	30	466 766	40	625 304
Locals	61	501 301	42	347 008	19	154 293
Total	135	2 093 296	75	1 210 787	60	882 509

Table 14-18: Plant Operations and Maintenance Labour

Position	Job Grade	Category	No. of Employees	Cost per Person per Month (US$)	Total Cost per Annum (US$)	Annual Cost to Company (US$)
Plant Operations Management						
Process Plant Manager	E3	Expatriate	1	12 538	150 455	191 189
Plant Clerk	B1	Local	1	435	5 215	6 824
Plant Superintendent	D4	Expatriate	1	6 533	78 392	102 912
Plant General Supervisor	D2	National	1	2 283	27 398	35 846
Senior Metallurgist	D4	Expatriate	1	6 533	78 392	102 912
Plant Metallurgist	D1	National	1	1 939	23 273	30 449
Shift Supervisor	C3	National	4	1 407	16 879	88 333
Control Room						
Control Room Operator	B3	National	4	731	8 768	45 885
Crushing						
Crusher Shift Operator	B3	National	4	731	8 768	45 885
Attendant	B1	Local	4	435	5 215	27 294
Milling						
Mill Shift Operator	B3	National	4	731	8 768	45 885
Attendant	B1	Local	4	435	5 215	27 294
CIL, Elution						
CIL Shift Operator	B3	National	4	731	8 768	45 885
Elution Operator	B3	National	4	731	8 768	45 885
A/L+sick coverage	B3	Local	3	731	8 768	34 414
Gold Room						
Gold Room Supervisor	C4	National	1	1 566	18 787	24 579
Gold Room Operator	B3	Local	2	731	8 768	22 942

Position	Job Grade	Category	No. of Employees	Cost per Person per Month (US$)	Total Cost per Annum (US$)	Annual Cost to Company (US$)
Tailings						
TSF Supervisor	C4	National	1	1 566	18 787	24 579
Tailings Operator	B3	Local	4	731	8 768	45 885
Tailings Attendant	B1	Local	8	435	5 215	54 588
Reagents and General Crew						
Reagents Supervisor	C3	National	1	1 407	16 879	22 083
Reagents Driver/Operator	B3	Local	4	731	8 768	45 885
Reagent Attendant	B1	Local	8	435	5 215	54 588
Metallurgical Laboratory						
Metallurgical Laboratory Technician	B3	National	1	731	8 768	11 471
Sample Preparer	B1	Local	4	435	5 215	27 294
Subtotal Plant Operations			**75**	**45 684**	**548 212**	**1 210 787**
Plant Maintenance Management						
Plant Maintenance Superintendent	D4	Expatriate	1	6 533	78 392	102 912
General Maintenance Supervisor	D2	National	1	2 283	27 398	35 846
Planner - Process Maintenance	D2	National	1	2 283	27 398	35 846
Mechanical Supervisor	C4	National	1	1 566	18 787	24 579
Electrical Supervisor	C4	National	1	1 566	18 787	24 579
Instrument Supervisor	C4	National	1	1 566	18 787	24 579
Plant Mechanical Maintenance Labour						
Fitter	B4	National	12	813	9 759	153 213
Fitter Assistant	B1	Local	6	435	5 215	40 941
Boilermaker	C1	National	2	1 007	12 089	31 634
Boilermaker Assistant	B2	Local	3	621	7 448	29 233
Electrical Maintenance Labour						
Electrician	C1	National	8	1 007	12 089	126 536
Electrical Assistant	B2	Local	4	621	7 448	38 977
Instrumentation Maintenance Labour						
Instrument Technician	C1	National	4	1 007	12 089	63 268
Instrument Technician Assistant	B2	Local	4	621	7 448	38 977
General Maintenance Labour						
Crane Driver	B4	National	4	813	9 759	51 071
Rigger	B4	National	4	813	9 759	51 071
Rubber Liner	A2	National	1	196	2 356	3 083
Greaser	A2	Local	2	196	2 356	6 165
Subtotal Maintenance			**60**	**23 947**	**287 364**	**882 509**
TOTAL PROCESS PLANT LABOUR			**135**	**69 631**	**835 576**	**2 093 296**

14.8.8 Maintenance, Parts and Supplies

Plant maintenance, parts and supplies costs refer to the costs of operating spares and lubricants for the plant. It has been assumed that the plant will experience a moderate amount of wear and maintenance costs have been calculated accordingly. Though moderate wear is expected overall, the plant will experience varying levels of maintenance requirements throughout the life of mine. Maintenance costs will be very low at the beginning, increasing as the equipment wear reaches a peak at the end.

The factors applied over different periods during the life of mine are shown in Table 14-19 below.

Table 14-19: Maintenance, Parts and Supplies Factors

Item	Overall LOM	Years 1-3	Years 4-9	Years 10-11
Mechanical Equipment	5.0 %	2.5 %	5.0 %	7.5 %
Piping and Valves	2.5 %	2.5 %	2.5 %	2.5 %
Electrical	5.0 %	2.5 %	5.0 %	7.5 %
Instrumentation	1.0 %	1.0 %	1.0 %	1.0 %

14.8.9 Assay Laboratory Costs (Mining & Process Plant)

The laboratory operating philosophy for the mining grade control and process plant assaying was as follows:

- The number of grade control (mining) samples generated per annum was estimated by Snowden based on the mining schedule.
- The plant metal accounting and control samples were selected in consultation with the Client. These were used to generate the number of process plant samples per annum.
- The analyses to be conducted on both grade control and process samples were decided in consultation with the Client.
- Other analyses such as water tests, and size by size, were also included as part of the assay cost.
- The laboratory equipment and building will be purchased by the mine. This has been included in the capital cost estimate.
- The laboratory management labour will be supplied by the selected assay laboratory company and will be included as part of the fixed cost.
- The laboratory equipment, software licence and communications costs were included in the fixed cost.
- The laboratory operational national labour will be supplied by the mine.
- Sample preparation and laboratory consumables costs will be included in the variable cost portion.

A summary of the LOM sample quantities and analyses is shown in Table 14-20 below.

Table 14-20: Summary of the Estimated Sample Quantities per Annum and Analyses Requirements

Sample Type	Estimated No. of Samples/Annum	Analyses Required & Method
Grade Control	6 000-7 500	Dry, Weigh, Crush, Pulverise, Split
Process	730	
Process	730	Filtering
Grade Control	6 000-7 500	50 g Au by Fire Assay AAS finish
Mill Feed/Tail samples	730	
Carbon Samples	240	Sample is weighed, ashed, and digested in aqua-regia. Resulting solution has Au value determined by AAS. Duplicate analysis
Solution samples	865	Au in CN liquors by extraction. AAS Finish
Bottle Roll	70	Au by cyanide leach, extraction and AAS, 500 g nominal sample weight
Bullion Samples	50	Au in bullion samples by fire assay and gravimetric finish
Moisture Test	90	Determination of moisture by gravimetric analysis
Size analyses	300	Size analyses, maximum three screens
Carbon Activity Test	270	Measuring carbon Au loading and referenced against activated virgin carbon
Cyanide Speciation	30	Free Cyanide, WAD Cyanide
Water Samples	230	Geochemical analysis of groundwater samples

14.9 GENERAL AND ADMINISTRATION (G&A) COSTS

G&A costs were estimated to be US$ 7.1 million per annum for years 1 to 10. G&A spend halves to US$ 3.6 million per annum when mining operations cease and the low grade stockpiles feed the mill in years 11 to 13. This was determined by using information from SENET, the Client and first principles, where applicable. These costs cater for the following items:

- G&A labour salaries
- Camp food and catering costs
- Camp, infrastructure buildings and vehicle maintenance
- Off-site office
- Supplies and spare parts
- Security contractor
- Other administration costs

Table 14-21 gives a summary of the G&A costs per annum.

Table 14-21: Summary of G&A Cost

Description	Unit	Cost ($US,000)
G&A Salaries	**US$/a**	**2,487**
Camp Food and Catering	**US$/a**	**746**
Maintenance	**US$/a**	**809**
Main Camp Maintenance and Cleaning	US$/a	257
Infrastructure Buildings	US$/a	100
Vehicles – Maintenance	US$/a	317
Vehicles – Fuel	US$/a	135
Off-Site Office - Addis Ababa Office	**US$/a**	**360**
Supplies and Spare Parts	**US$/a**	**69**
Administration	US$/a	10
Human Resources	US$/a	10
Accounting	US$/a	10
Safety Supplies Administration	US$/a	12
Warehouses	US$/a	9
Medical	US$/a	18
Security Contractor	**US$/a**	**378**
Other Administration Costs	**US$/a**	**2,288**
Communication	US$/a	91
Couriers	US$/a	6
Insurances	US$/a	124
Licence fees for software	US$/a	18
Computer hardware upgrade	US$/a	6
Consultant Fees	US$/a	12
Accounting tax audit and legal	US$/a	48
Training	US$/a	69
Recruiting	US$/a	169
Environmental & Social G&A	US$/a	240
Ongoing Closure & Rehab	US$/a	125
Access & Bypass Road Maintenance	US$/a	180
Corporate Management Fee	US$/a	1,200
Total G&A	**US$/a**	**7,137**
Total G&A	**US$/t**	**5.39**

14.9.1 General and Administration Labour Costs

The estimated G&A labour costs were supplied by the Client, and include the labour complement, the positions, the category (expatriate, national or local), the level and number of employees required.

The G&A expatriate, national and labour costs includes the cost breakdown allowed for the process plant labour and can be referenced in Section 14.8.7. The job grading and category description for G&A labour can also be referenced in this section.

Table 14-22: G&A Labour Costs

Position	Job Grade	Category	No. of Employees	Cost per Person per Month (US$)	Cost per Person per Annum (US$)	Annual Cost to Company (US$)
General Management						
Managing Director (MD)/Chief Operating Officer (COO)	E5	Expatriate 1	1	20 075	240 897	306 042
Government Liaison Officer	C4	National	1	1 566	18 787	24 579
Executive Secretary	C1	National	1	1 007	12 089	15 817
Legal Counsellor	D2	National	1	2 283	27 398	35 846
Subtotal General Management			**4**	**24 931**	**299 171**	**382 284**
Finance						
Finance Manager	E1	Expatriate 1	1	11 284	135 406	176 816
Senior Accountant	D2	National	1	2 283	27 398	35 846
Accountant	C4	National	2	1 566	18 787	49 159
Accounts Clerk	B1	Local	2	435	5 215	13 647
Senior Salary Clerk	B1	National	1	435	5 215	6 824
Salary Clerk	A3	Local	2	280	3 365	8 805
Subtotal Finance			**9**	**16 282**	**195 387**	**291 096**
Human Resources and Administration						
HR and Administration Manager	D5	National	1	4 229	50 752	66 400
HR Superintendent	D4	National	1	3 372	40 459	52 934
HR Officer	C4	National	2	1 566	18 787	49 159
HR Clerk	B1	Local	1	435	5 215	6 824
Travel Co-ordinator	C1	Local	2	1 007	12 089	31 634
Training and Development Superintendent	D3	Expatriate 2	1	5373	64 475	85 864
Training Officer – General	C4	National	6	1 566	18 787	147 476
IT Administrator	D3	National	1	2 688	32 254	42 198
IT Maintenance and Networking Engineer	C4	National	1	1 566	18 787	24 579
Database Administrator	C3	National	2	1 407	16 879	44 167
Service Buses/LV Driver	B2	Local	5	621	7 448	48 721
Receptionist	B3	Local	2	731	8 768	22 942
Subtotal Human Resources and Administration			**25**	**24 558**	**294 699**	**622 897**
Health, Safety, Security (HSS)						
Health and Safety Manager	E1	Expatriate 2	1	7 606	91 273	118 691

Position	Job Grade	Category	No. of Employees	Cost per Person per Month (US$)	Cost per Person per Annum (US$)	Annual Cost to Company (US$)
Health and Safety Manager - Training	C4	National	1	1 566	18 787	24 579
Security Superintendent	D3	National	1	2 688	32 254	42 198
Paramedic	D2	Expatriate 2	2	3 933	47 200	129 404
Paramedic Training	C4	National	3	1 566	18 787	73 738
Nurse	C2	National	3	1 264	15 165	59 522
Ambulance Driver	B3	Local	2	731	8 768	22 942
Safety Officer	C3	National	3	1 407	16 879	66 250
Health and Safety Clerk	B1	Local	1	435	5 215	6 824
Subtotal HSS			**17**	**21 194**	**254 327**	**544 149**
Commercial (Purchasing and Supplies)						
Commercial Manager	E1	Expatriate 2	1	7 606	91 273	118 691
Logistics Superintendent – Training	C5	National	1	1 743	20 910	27 357
Chief Buyer	D1	Expatriate 2	1	3 725	44 700	61 640
Chief Buyer – Training	C4	National	1	1 566	18 787	24 579
Buyer	C3	National	1	1 407	16 879	22 083
Data Clerk	A3	Local	1	280	3 365	4 402
Telephone/Radio Operator	B2	Local	2	621	7 448	19 488
Warehouse Superintendent - Training	C4	National	1	1 566	18 787	24 579
Fuel, Lubricants and Filter Storekeeper	B3	Local	1	731	8 768	11 471
Fuel Farm Attendant (Light Vehicle)	B1	Local	1	435	5 215	6 824
Fuel Farm Attendant (Heavy Vehicle)	B1	Local	2	435	5 215	13 647
Tools Storekeeper	B2	Local	1	621	7 448	9 744
Chemicals and Explosives Storekeeper	B3	Local	1	731	8 768	11 471
General Supplies Storekeeper	B3	Local	1	731	8 768	11 471
Store Attendant	B2	Local	2	621	7 448	19 488
Inventory Controller	C3	National	1	1 407	16 879	22 083
Subtotal Commercial			**19**	**24 221**	**290 657**	**409 021**
Environmental and Social						
Environment and Social Manager	D5	National	1	4 229	50 752	66 400
Environment Co-Ordinator	C4	National	1	1 566	18 787	24 579
Environment Officer	C3	National	1	1 407	16 879	22 083
Field Technician	A3	National	5	280	3 365	22 011
Nursery Supervisor	B1	Local	1	435	5 215	6 824
Nursery Worker	A1	Local	3	138	1 650	6 476
Senior Community Relations Officer	D2	National	1	2 283	27 398	35 846
Community Relations Officer	C4	National	1	1 566	18 787	24 579
Resettlement and Livelihood Restoration Officer	C4	National	1	1 566	18 787	24 579

Position	Job Grade	Category	No. of Employees	Cost per Person per Month (US$)	Cost per Person per Annum (US$)	Annual Cost to Company (US$)
Environment and Social Clerk	A3	Local	1	280	3 365	4 402
Subtotal Environmental and Social			**16**	**13 749**	**164 984**	**237 781**
Total G&A			**90**	**124 935**	**1 499 223**	**2 487 227**

14.9.2 Camp Accommodation and Catering

Expatriate and national construction labour will be accommodated in the camp and all catering will be included. The local labour will also receive a basic packed-lunch.

The food cost was determined by obtaining quotes from catering companies.

14.9.3 Camp, Infrastructure Buildings and Vehicle Maintenance

The maintenance costs are based on the following:

- Camp Maintenance and Cleaning - These costs were established from quotations received.
- Infrastructure Buildings – A cost allowance was made and was based on SENET's in-house database.
- Vehicle Maintenance – The maintenance cost per annum was determined by using each vehicle's purchase amount and applying a 10 % factor.
- Vehicle Fuel – The fuel cost was based on estimated travelled kilometres per annum and the fuel cost of US$0.84/L supplied by the Client.

14.9.4 Off-Site Offices

An allowance of US$360 000 per annum has been made to cover the Tulu Kapi Addis Ababa office costs for staff salaries and other office amenities for staff providing logistic and government liaison.

14.9.5 Supplies and Spare Parts

An allowance was made for the following project areas and costs were based on costs supplied by Client:

- Administration
- Human Resources
- Accounting
- Safety Supplies Administration
- Warehouses.

- Medical (including clinic maintenance and medical supplies)

14.9.6 Security Contractor

The cost for the security contractor was determined from quotations received from security companies

14.9.7 Other Administration Costs

The cost for communications includes maintenance and software updates for all communications equipment. This cost was determined from quotations received from communications services companies.

An allowance was made for the following costs and was based on costs supplied by Client:

- Couriers
- Insurances
- Licence fees for software
- Computer hardware upgrade
- Consultant fees
- Accounting tax audit and legal
- Training

Recruitment cost was based on a staff turnover of 20 % at a recruitment cost percentage of 10 % of annual salary.

14.9.7.1 Environmental and Social Infrastructure

Environmental costs relate to various areas shown in the table below with the following annual allowances (all contributions will be made on an annual basis for the 10 years + 3 Years at 50%):

Table 14-23: Environmental and Social G&A

Description	Cost
Environmental & Social G&A	**239,750**
Consumables	11,250
Waste Management	10,000
Environment Training	6,000
Equipment Maintenance	5,000
Consultants	50,000
Laboratory & Monitoring	25,000
Equipment	25,000
Community Development Fund	100,000
Social Training	7,500
Ongoing Closure & Rehab	**125,000**
Access & Bypass Road Maintenance	**180,000**
Corporate Management Fee	**1,200,000**
TOTAL	**1,744,750**

A provision has been made totalling $100,000 to provide for Consultants, Laboratory Analysis and Equipment as required to support our Environment and Social monitoring plans and activities. In addition $125,000 for ongoing site rehab and closure activities beyond those carried out by the mine and process plant.

The commitment to the community in our Mining Licence Application was 2,000,000 Birr annually for Community Development, this equates to $100,000 a year.

14.9.7.2 Minesite Access Road

A provision of $180,000 per year for 10 years and $90,000 a year for years 11 to 13 to maintain the 15 kms of mine access road.

14.9.7.3 Corporate Management Fee

A provision has been made for management and services provided to KEFI Minerals Ethiopia by KEFI Minerals plc. The provision is $1,200,000 per year for the first 10 years of operation dropping to $600,000 at the cessation of mining until processing is completed in year 13.

14.10 TSF OPERATING COST ESTIMATE

The cost of operating the TSF has been estimated based on the assumption that the operation and management of the facility would be carried out by the metallurgical plant staff. Apart from the on-going construction of the containment walls as described above the costs associated with the operation of the TSF are expected to comprise the cost of establishing and maintaining on site the supervision, labour and equipment required to:

- Operate the slurry delivery and return water systems (priced as part of the operation of the plant)
- Manage and supervise the on-going construction of the downstream wall raises
- Construct the self-raised portion of the TSF in years 7 to 13

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15.1 LEASE

The Tulu Kapi licence is currently held as a mining licence. An application to convert it to a Large-Scale Mining Licence was made in October 2014 and the former exploration licence (MOM\EL\127-128/97) that encompassed the Tulu Kapi project was effectively replaced by a Mining Licence (MOM\LSML\81\2015) on 13 April 2015.

The mining licence location area and proposed project layout, which covers 7 km^2, is shown in Figure 15-1.

Geographic co-ordinates and the co-ordinates of the corner points of the mining licence area have been set out in Section 3 (Property Description and Location).

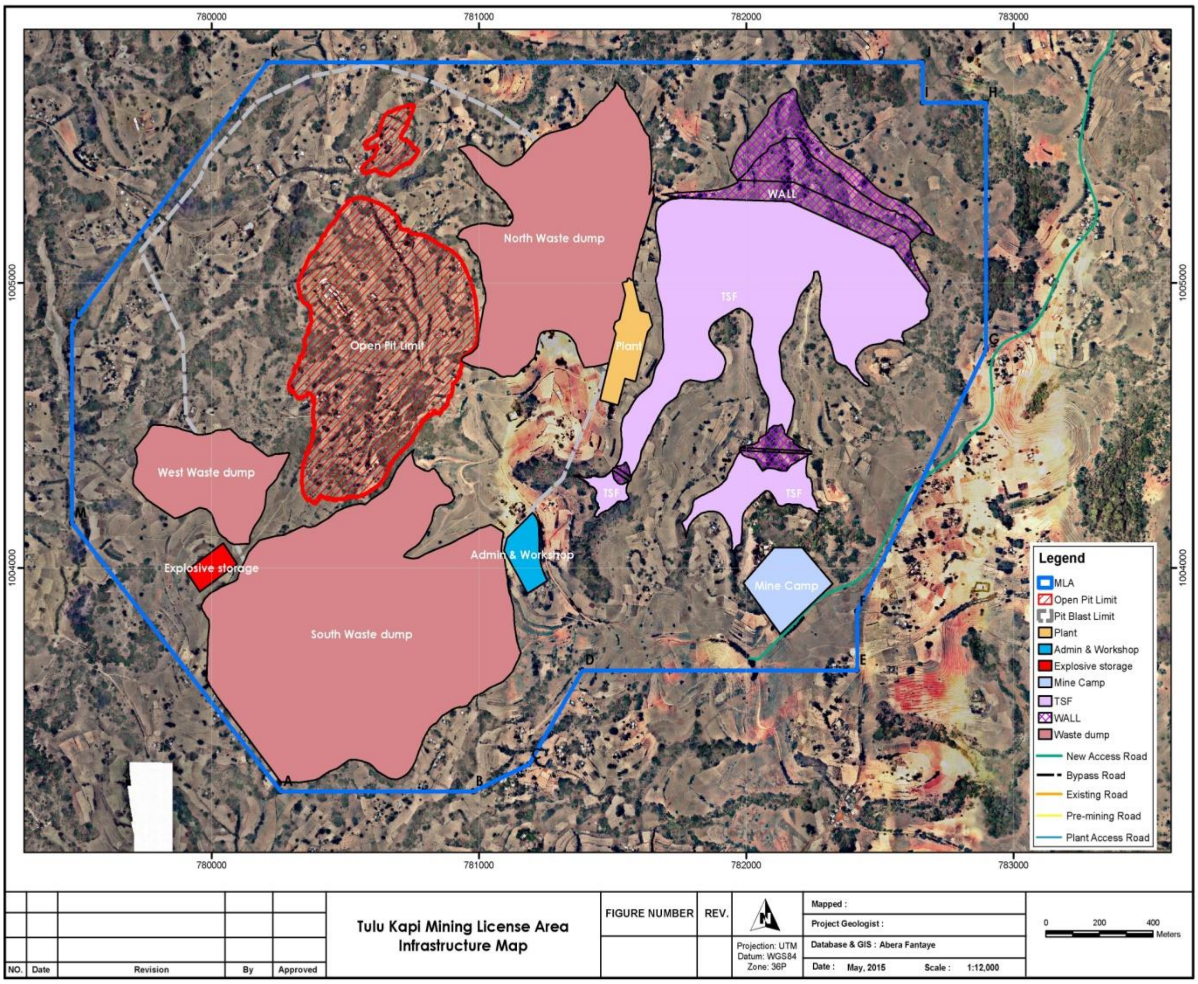

Figure 15-1: Tulu Kapi Gold Project Mining Licence Area

15.2 LAND TENURE

Under Ethiopian law, the mining licence grants the licence holder the right to build and operate a mine.

The signed mining licence and mineral agreement are valid for 20 years from the date of signing and can be renewed, with each renewal subject to a maximum period of 10 years.

In addition to the former Tulu Kapi exploration licence (MOM\EL\127-128/97), the Tulu Kapi mining licence area also includes the former Ankore Exploration Licence (MOM\EL\372/2010) area, a smaller 2.1 km^2 area within the southeast corner of the mining licence area. This smaller area was included in the conversion to provide the necessary space for associated infrastructure such as the tailing storage facility.

A review of the prospective geology and historical exploration data indicates that the retained Tulu Kapi mining licence area covers all known mineralisation associated directly with the Tulu Kapi deposit.

Adjacent and to the north of the Tulu Kapi licence area, KEFI holds the Guji-Getere prospecting licence (MOM\PL\631/2002). This licence covers an area of 8.88 km^2 and is currently subject to an application to the Ministry of Mines for conversion to an exploration licence.

NOTE: Older licences use the Ethiopian calendar as the suffix to denote the year of first issue. The Ethiopian calendar is seven years behind the Gregorian calendar and a new year commences on September 11 or 12 of the Gregorian calendar (e.g. 2005 commenced on September 11, 2012). Therefore, the suffix “97” denotes that the licence was issued during the 12 months commencing on 11 September 2004.

15.3 SURFACE RIGHTS

Surface land rights remain the property of the State. These include rights to farmland cultivated within and surrounding the Tulu Kapi project. Local residents have tenure to land from the State. Ethiopian law makes provision for the repossession of land that the government deems necessary for mining or other activities beneficial to the State. Any repossession and resulting loss of land improvements including homes and crops require compensation to be paid by the Company and in some cases, the government to relocate affected people to an appropriate new location.

In relation to KEFI’s activities, this process has been explained to the local residents by both the federal and regional authorities and all parties formed committees and working groups to conduct socio-economic and property surveys aimed at finding suitable host-resettlement land. Sufficient land has been found and the Oromia regional state land authority office are working in conjunction with the Gimbi zone and Genji Wereda administrations to conclude the compensation payment cost calculations. KEFI is working with the Gimbi zone, Genji Wereda and host Weredas on planning for the implementation of the Resettlement Action Plan (RAP), which will be implemented in phases.

15.4 AGREEMENTS

Ethiopia has a federal constitution that was proclaimed on 21 August 1995. This constitution has introduced changes to the judicial system and Ethiopia now has a three-layered federal and regional court system. There are federal and regional courts of first instance, a High Court and a Supreme Court topped by a Cassation Division within the Supreme Court to correct errors of law at all levels of both the federal and judicial courts. This latter court is the ultimate guardian of the rights embodied in the constitution.

Ethiopian law is essentially a combination of the civil law prevailing in continental Europe, and common law in matters of constitutional and commercial practices generally. The civil and commercial codes are of French and Swiss extraction, while the civil procedure code is of Indian extraction. The criminal law and criminal procedure codes are of Swiss and common law extraction, respectively.

Amharic and English are widely spoken in the country, together with other languages and dialects in the regional states.

The primary legislation governing exploration and mining operations in Ethiopia is contained in the following instruments:

- Mining Proclamation No. 678/2010 (Mining Proclamation) and its amendment of 816/2013
- Mining Operations Council of Ministers Regulations No. 22/1998 (as amended) (Mining Regulations)
- Mining Income Tax Proclamation No. 53/1993 and its amendment of 802/2013 (Mining Income Tax Proclamation)

The Mining Proclamation came into force as law in Ethiopia in August 2010 and replaced former Mining Proclamation No. 52/1993 (Old Mining Proclamation), on which the mining Regulations are based. Pursuant to Article 82(3) of the Mining Proclamation, the Mining Regulations shall, insofar as they are consistent with the Mining Proclamation, remain in force until they are replaced by regulations issued pursuant to the Mining Proclamation. As of the date of this report, no such replacement regulations have been issued. Accordingly, the Mining Regulations, together with the Mining Proclamation (and the Mining Income Tax Proclamation) continue for the time being to collectively establish the legislative framework surrounding exploration and mining operations.

Each of the licences in which KEFI has an interest (with the exception of the Ankore Exploration Licence) was granted under the terms of the Old Mining Proclamation. Pursuant to the Mining Proclamation, such licences remain in force for the remaining period of their validity.

In Ethiopia, the licensing authority in respect of mining rights is divided between the federal and regional governments under Article 52 of the Mining Proclamation. Regulations issued thereunder provide that the power to issue mining licences to domestic investors shall vest in the regional authorities, while mining licences for large-scale mining and all mining operations (including exploration and prospecting) in favour of foreign entities, individuals or corporate entities shall be issued by the Federal Ministry of Mines (MoM).

Accordingly, for KEFI's purposes and the purposes of this report, mineral licences in Ethiopia are awarded and managed by the MoM. The procedures and protocols required to maintain licences in good standing are typical of legislation applied in other West and East African mining economies.

The key mining agreement that KEFI has entered into will govern the terms and conditions of the development of the Tulu Kapi project.

15.4.1 Mining Agreement

When the Mining Licence was issued, a Mining Agreement with the Government of Ethiopia, which sets the fiscal regime, taxation and royalties as they affect the operation of the mine, was also signed. The Licence and Mineral Agreement were signed by KEFI and the Company's wholly owned subsidiary on 13 April 2015, and are valid for 20 years. The Mining Licence can be renewed, with each renewal subject to a maximum period of 10 years.

15.4.2 Resettlement Action Plan (RAP)

The terms of the RAP are based on the provisions in the Mining Agreement.

15.4.3 Power Supply Agreement

To supply power to the Tulu Kapi site, KEFI will need to enter into a power supply contract with the Ethiopian Electric Power Corporation (EEPCo).

15.4.4 Project Finance

KEFI will enter into contractual arrangements with finance providers, which may take the form of development finance institutions (DFIs), commercial banks or other parties, to raise the funds needed to develop and maintain the Tulu Kapi mine and processing plant. Several of these agreements are likely to require the Ethiopian government to sign as a party to the contained terms.

15.5 ROYALTIES

According to Mining Proclamation 678/2010, the holder of a mining licence shall pay royalties once mining operations commence, based on the sales price of the commercial transactions of the minerals produced. Under the Mining Proclamation, royalties for precious metals (including gold) in Ethiopia are set at 7 %. However, the Mining Proclamation also specifies that the MoM may, in circumstances it deems appropriate, cause the reduction, suspension or waiver of the payment of royalties; indicating that the above rate may be negotiable with the MoM.

15.6 MARKET STUDIES

15.6.1 Tulu Kapi Gold Sales

Gold metal markets are mature, with many reputable refiners and brokers located throughout the world. The advantage of gold, like other precious metals, is that virtually all production can be sold in the market. As such, detailed entry strategies are not required.

Metallurgical process studies confirm that the Project will produce doré of a specification comparable with existing operating mines.

The project is planned to produce approximately 85 000 troy ounces per annum of gold contained in doré. Gold and silver content is expected to be approximately 98 % (the remaining 2 % content is likely to be copper and zinc). Gold content is expected to account for approximately 70 % of the precious metal content, with the remaining amount in silver. No deleterious elements are indicated. Doré production will be an average of approximately 120 000 troy ounces per annum.

Doré bars are planned to be cast in bricks that are approximately 800 troy ounces (25 kg), with approximate dimensions of 220 mm (length), 140 mm (width) and 70 mm (height). Fifteen pours per month are planned and approximately 2 500 ounces of doré will be transported weekly from the mine site to the export facilities at Addis Ababa airport (basis of 48 operational weeks per annum). Doré will be packed and secured in high security tamper-evident carry boxes (see Figure 15-2) in the gold room in the presence of government officials following weighing, sampling and assaying.

Figure 15-2: Tamper-Evident Security Box

An industry standard gold room and strongroom facilities will be constructed on site to store the doré until it is ready for export. Appropriate checks and balances, security cameras, alarms, insurance and security procedures will be implemented to cover the production and storage at the mine. Maximum storage on site will be no more than two weeks' production, unless exceptional circumstances dictate otherwise.

Irregular transport schedules from the mine site will be used. Customs, export and central bank documentation, including weights, assays and proforma invoices, will be completed on site. The doré will be transported from the strongroom to the airstrip in a secure vehicle with an appropriate escort designed for the purpose in accordance with international codes.

Doré will only leave the strongroom when it is confirmed that the plane is on final approach in order to minimise ground time. The security escort will depart from the airstrip when the plane's flight plan set for Addis Ababa has been confirmed.

On arrival at Addis Ababa airport, arrangements will be in place for immediate export. Typically, an experienced company such as Brink's or G4S will arrange this secure transport through to delivery at the international refinery of choice. It is not expected that the doré will ever need to be stored at the airport in Addis Ababa, however, contingency arrangements will be in place in case of flight delays.

There are a number of refineries suitable for transforming the doré into refined gold bullion, including facilities in South Africa, Europe, North America and the Middle East. The key determinants in choosing the refinery will be credit standing and experience of refining, pricing and refining terms, transport and insurance costs, and ease of logistics. Refineries and transport groups have provided costing indications that are incorporated in this DFS. They will be asked to provide firm quotes six months before the start of commercial production.

15.6.2 Gold Market

Gold is considered a rare commodity. At the end of 2013, there were 177 200 metric tonnes of mined stocks.

According to the World Gold Council, gold demand in 2014 reached 3 924 tonnes. The annual total was down 4 % compared to the 2013 total as consumer demand in 2014 never matched 2013's record surge. In value terms, the annual gold demand was US$171.5 billion.

The demand for this precious and finite natural commodity occurs in many geographies and sectors. Around 45 % of today's gold becomes jewellery, where India and China with their expanding economic power are at the forefront of consumption.

The combined demand volumes in India and China have grown by 71 % over the last 10 years. The two markets accounted for 54 % of the consumer gold demand in 2014, up from 33 % in 2005.

Jewellery, however, constitutes only one source of demand; investment, central bank reserves and the technology sector are all significant. Each is driven by different dynamics, adding to gold's strength and independence. Rapid demographic and other socio-economic changes in many of the key consuming nations are also likely to produce new patterns of demand in the foreseeable future.

In creating supply, gold mining companies operate on every continent of the globe. This broad geographical dispersal means that issues, political or otherwise, in any single region are unlikely to impact the supply of gold. Beyond mine production, recycling accounts for approximately a third of all current supply. In addition, central banks can also contribute to supply should they sell part of their gold reserves.

The gold market system was well balanced in Q1 2015. Conditions differed from market to market, but at an aggregate level, these differences broadly cancelled each other out. Global demand in Q1 2015 dipped by 1 % to 1 079.3 tonnes compared to 1 089.9 tonnes in Q1 2014.

The total gold supply changed little in 2014 as compared to 2013. Recycling decreased to a seven-year low, while annual mine production increased for the sixth straight year, nudging up 2 % to 3 114.4 tonnes.

Looking forward, the supply from existing or developing projects continues to diminish and is likely to cap out in 2015 as the supply pipeline thins. Gold producers, contending with far lower gold prices than in previous years and wrestling with cost pressures, have not been able to invest in many new projects in recent years. Given this shortage of new projects, the world gold council remains of the view that mine production will plateau in the next couple of years.

15.7 CONTRACTS

KEFI will enter into contractual arrangements to secure capital equipment for the Tulu Kapi project, in particular long lead-time items such as the ball mill.

Currently, there are no material contracts in place other than those disclosed in this DFS. However, KEFI has obtained quotes for future service needs. It is anticipated that the following contracts will be in place upon Project commencement:

- Secure doré transportation to refinery
- Doré refining
- Supplier and service contracts, including the following:

    - Diesel and fuel oil
    - Process reagents
    - Equipment preventive maintenance services
    - Air transportation services
    - Site security services
    - Inland freight services to project site
    - Camp management, catering and support services
    - Laboratory services
    - Mine consumables
    - Explosives supply
    - Surface infrastructure construction

15.8 PERMITTING

The operation of a mine and processing facility at Tulu Kapi is subject to a number of permitting requirements at local and federal level. Those detailed in Table 15-1 below are the main ones that will be required.

Table 15-1: Permitting Requirements

Requirement	Type of Work	Regulation/Permit	Government Authority	Required by	Comments
ESIA Compliance Letter	Environmental and social impact assessment	Proclamation 299/2002	Ministry of Mines	13/04/2015	Issued on 09/04/2015
Cultural Heritage Study	Exploration /study	Proclamation 209/2000	Cultural Heritage	30/09/2015	As part of SEIA
Waste Disposal	Generate, store, transport, treat, or dispose of hazardous waste	Proclamation 300/2002	Environmental Pollution Control	01/11/2015	Required in order to commence construction
Chemical Use	Importation, preparation, storage, distribution, transport or use of chemicals categorized as hazardous or restricted use	Proclamation 300/2002	Environmental Pollution Control	01/10/2016	Required in order to commission the processing plant
Water Use Permit	Use of water resources, discharge of waste, construction of waterworks	Proclamation 197/2000	Water Resources Management	N/A	As designed, the mine will not require this permit to operate
Water Use Permit	Use of project water in line with water resources management	Proclamation 534/2007	River Basin Councils and Authorities	01/01/2016	Required for release of water to baseline conditions to local waterways
Nuclear Permit	Importation or transportation or use of radioactive substances	Proclamation 300/2002	Environmental Pollution Control	01/01/2016	Required in order to import process plant components
Communication Licences	VSAT, radios	-	-	Ongoing	KEFI already has VSAT and radio licences
Electrical	For 15 MW supply of power	Regulation 170/2009	Ethiopian Electric Power Corporation	01/01/2016	Start processing immediately upon approval of the mine development plan
Explosives Use Permit	For blasting	-	Ethiopian Security Agency	01/01/2016	Not expected for initial mining

Requirement	Type of Work	Regulation/Permit	Government Authority	Required by	Comments
Trading Licence	For importation of goods		Ministry of Trade	N/A	Registration required – but Mining Licence is equivalent
Health Permit	Constructing buildings for public services	Proclamation 200/2000	Ministry of Public Health	[01/03/2016]	In addition to local health authority; may be required for resettled peoples and camp health post
Timber Removal	For removal of timber to local markets	Proclamation 542/2007	Forest Development, Conservation and Utilisation	[N/A]	Only in the event that trees are cut and moved to market
Tree Removal Permit	For removal of trees during project construction		Oromia Forestry and Wildlife Directorate	[01//12/2015]	Will be required to commence construction works
Road Construction Permit	Construction of gravel road to rural standards		Oromia Regional Roads Authority	[01/11/2015]	Already engaged in design criteria. Required in order to proceed to tender.
Construction Permit	Construction of buildings for camp	Proclamation 624/2009	Ethiopian Building designated organisation	[01/11/2015] [Unclear if and how this is applicable]	Planning consent required in order to obtain a permit.

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SECTION 16 Project Financial Analysis

Tulu Kapi Gold Project Definitive Feasibility Study

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16.1 INTRODUCTION

The Tulu Kapi project economics have been evaluated using the discounted cash flow method, by taking into account milled tonnages and grades for the ore and the associated recoveries, gold price (revenue), operating costs, bullion transport and refining charges, royalties, corporation tax and capital expenditure (both initial and sustaining). The project has been evaluated as a stand-alone and 100 % equity financed project, with no debt financing.

The base case assumes an owner operator mining fleet. A mining contractor scenario has been evaluated in Section 16.5

16.2 KEY ASSUMPTIONS

The following key assumptions have been used in the financial analysis:

- Base Case: Owner-mining and all-new processing plant
- Initial Capital US$175.6 million (US$141.3 million in contract mining scenario)
- Peak Funding: US$168.2 million (US$129.6 million in contract mining scenario)
- Gold Price: US$1 250/oz flat (in real terms)
- Royalties: 7.0 % government royalty payable on revenues net of refining and transport costs
- Value-Added Tax: 15 % on all expenses excluding labour, reimbursed the month after payment.
- Depreciation: Straight line method over four years from the time production commences for all capital expenditure and capitalised pre-production expenditure
- Corporation Tax: 25 % applied to taxable profit after taking into account historical loss carry forwards.
- Inflation: Results of the financial model have been presented in real terms
- Working Capital: Minimum 2 months of operating costs provided for in peak funding requirement as a working capital buffer
  Reduced to 1 month of operating costs during operating phase

Mining and processing physicals, operating costs and capital costs have been sourced from the relevant sections of this DFS. Following completion of the DFS, KEFI will now move forward to detailed engineering and procurement during which efforts will continue to seek opportunities for savings in schedule and costs where possible.

16.3 RESULTS OF FINANCIAL ANALYSIS

The results of the financial analysis are summarised in Table 16-1, Table 16-2 and Table 16-3.

Table 16-1: Operational Summary

Description	Unit	Quantity
Ore mined	t	15.4M
Waste mined	t	114.2M
Strip ratio	multiple	7.42
Feed grade	g/t	2.12
Life of mine	years	13
Gold recovery	%	91.5
Gold production	oz	961 333
Gold production (steady-state)	oz/a	95 000

Table 16-2: Summary of Base Case Operating Costs (excluding royalty)

Area	Unit	Cost
Mining costs	US$/oz	357
Processing costs	US$/oz	133
General and administrative costs	US$/oz	86
Total cash operating costs	**US$/oz**	**577**

Table 16-3: Base Case Financial Summary (post-tax)

Description	Unit	Value
NPV at 8.0 % real discount rate	US$	118M
IRR (nominal, unleveraged)	%	21.9
Net undiscounted cash flow	US$	270M

As evident from Table 16-3, the project's post-tax IRR is 21.9 % on an unleveraged basis (all-equity) and the project's post-tax NPV at an 8 % discount rate is US$118 million. A 10 % increase in the gold price increases the estimated rate of return to 27.6 % and increases the project's NPV, at an 8 % discount rate, to US$172 million.

The cashflow profile is set out in Figure 16-1.

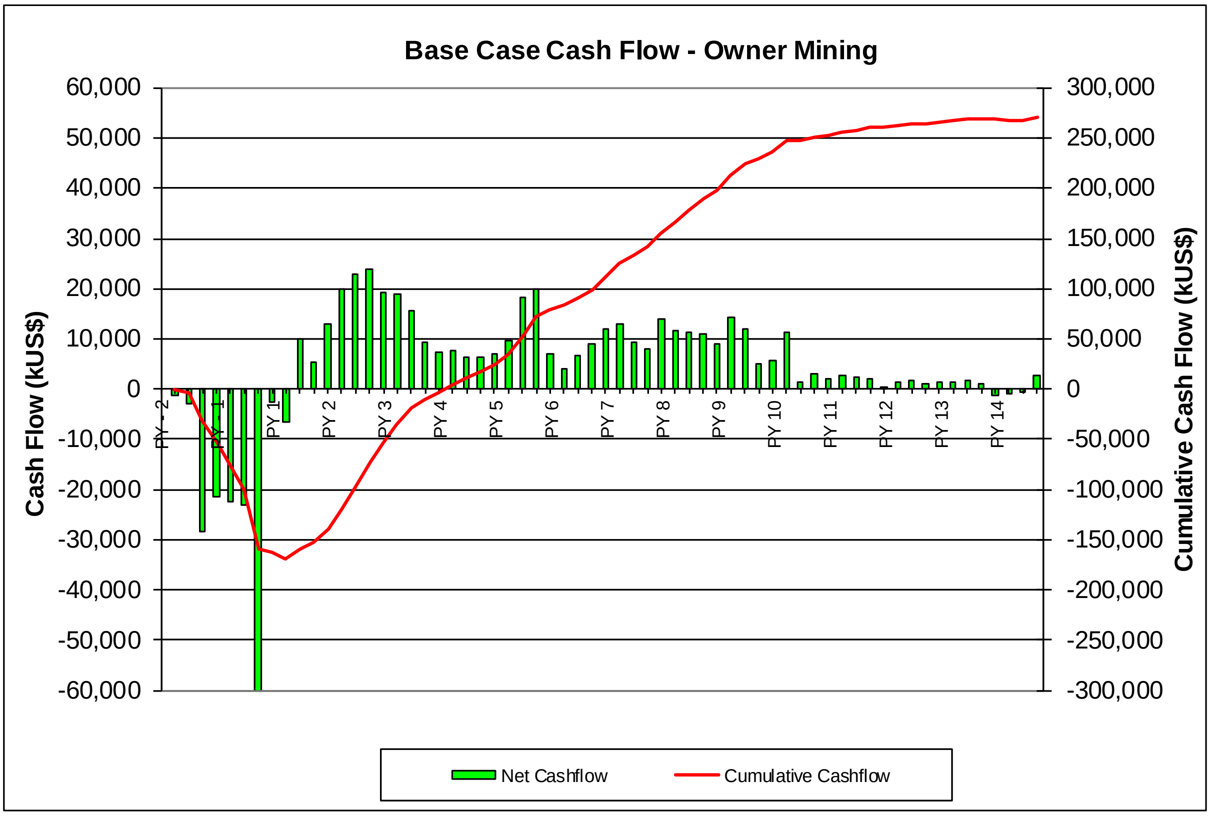

Figure 16-1: Base Case Cashflow – Owner Mining

The peak funding requirement of $168.2 million reflects an assumption that the EPCM contractor's final payment of 10% is one quarter after first gold production. It also assumes that a minimum of two months' operating costs are preserved as a working capital buffer.

Cashflow generation during the first two production quarters totals US$7.3 million and explains the difference between initial capital of US$175.6 million and the peak funding requirement of US16823 million.

16.4 SENSITIVITY ANALYSIS

A sensitivity analysis was performed on the NPV by varying the key variables (gold price, initial capital expenditure, and operating costs) to ± 10 % of the base case cashflow and each sensitivity was performed independent of the other. The results of the sensitivity analysis are shown in Figure 16-2 and Figure 16-3 and summarised in Table 16-4, Table 16-5 and Table 16-6.

When ranked, the sensitivity analysis indicates that the project is most sensitive to gold price followed by operating costs and initial capital expenditure. These results are typical of similar projects.

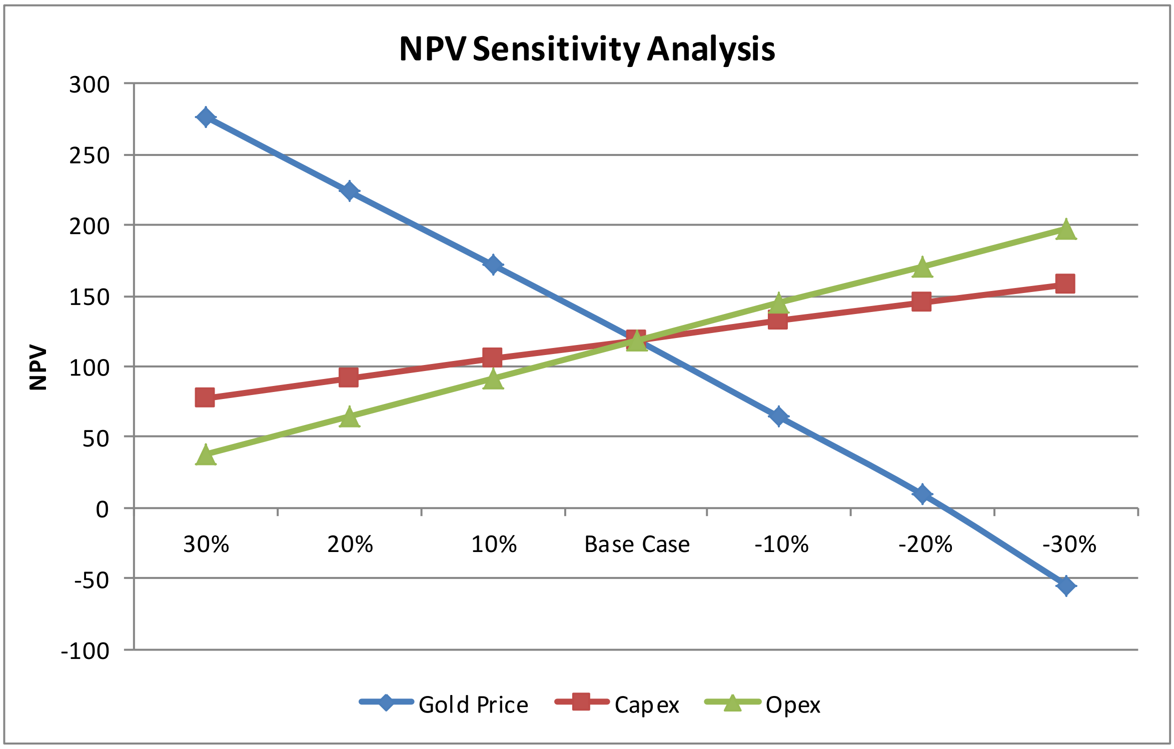

Figure 16-2: NPV Sensitivity Analysis – Base Case

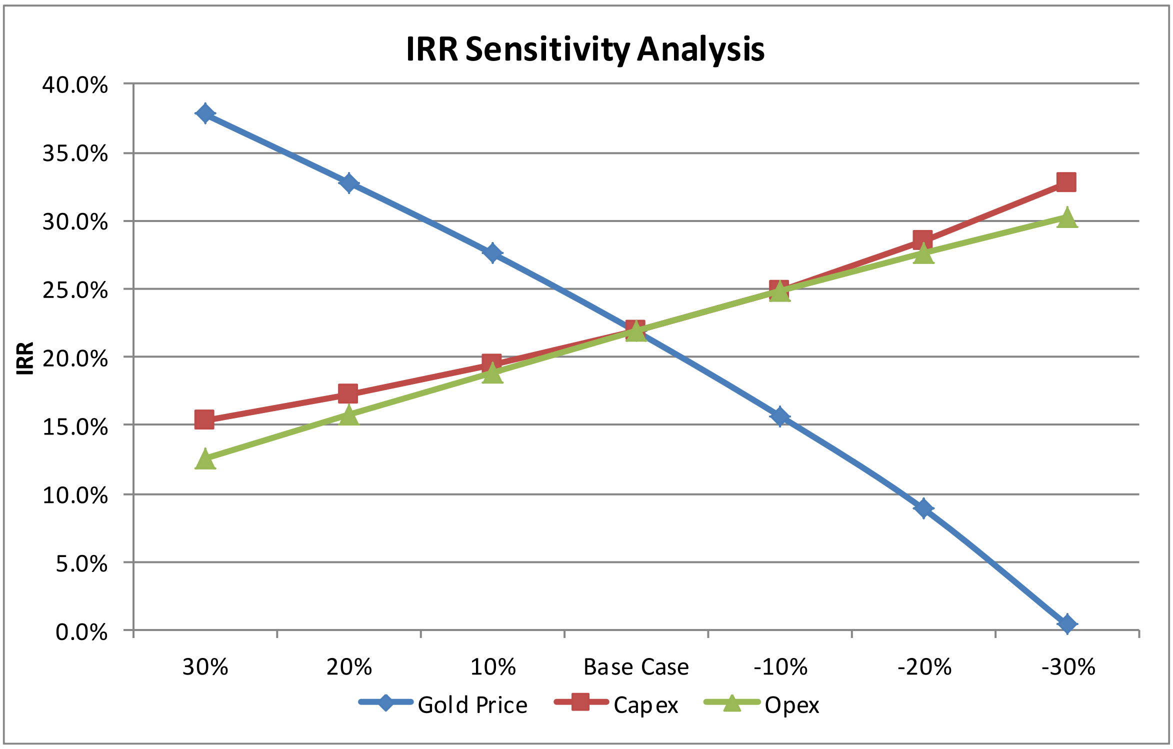

Figure 16-3: IRR Sensitivity Analysis – Base Case

Table 16-4: Sensitivity to Gold Price – Base Case

Option	Gold Price (US$/oz)	IRR (%)	NPV (US$M)
30 %	1 625	37.8	276
20 %	1 500	32.8	224
10 %	1 375	27.6	172
Base Case	**1 250**	**21.9**	**118**
-10 %	1 125	15.7	64
-20 %	1 000	8.9	9
-30 %	875	0.4	-55

Table 16-5: Sensitivity to Initial Capital Costs – Base Case

Option	CAPEX (US$M)	IRR (%)	NPV (US$M)
30 %	228	15.3	78
20 %	211	17.2	91
10 %	193	19.4	105
Base Case	**176**	**21.9**	**118**
-10 %	158	24.9	132
-20 %	140	28.4	145
-30 %	123	32.7	158

Table 16-6: Sensitivity to Operating Costs – Base Case

Option	OPEX (US$M)	IRR (%)	NPV (US$M)
30 %	721	12.5	37
20 %	666	15.8	65
10 %	610	18.9	92
Base Case	**555**	**21.9**	**118**
-10 %	499	24.8	145
-20 %	444	27.6	171
-30 %	389	30.2	197

16.5 MINING CONTRACTOR SCENARIO

KEFI plans to appoint a mining contractor and, to that end, has:

- Completed the DFS on the basis of owner-mining, as a base case for understanding of costs from first principles

- Conducted a preliminary bidding process based on the 2014 mine plan which resulted in the selection of short-list candidates
- Invited bids from the short-listed candidates, to be based on the final 2015 mine plan and which are expected in August 2015
- Completed a financial scenario reported herein, which simulates the financial impacts of the appointment of the mining contractor. This simulation is preliminary and will be replaced by the results of firm bids during 2015

In the contractor mining scenario, initial capital costs are reduced to US$141.3 million from US$175.6 million in the base case owner mining scenario. The US$34.3 million reduction includes the:

- Removal of US$21.2 million mining fleet purchase
- Removal of $3.0 million of other initial mine development costs
- Mining contractor funding US$10 million of the mining pre-strip costs and infrastructure construction costs.

Sustaining capital related to owner mining is also removed from the contractor scenario, which increases cashflow generation during the first two quarters of gold production to US$11.7 million from US$7.4 million in the owner mining scenario.

Accordingly, the peak funding requirement for the mining contractor scenario is estimated to be US$129.6 million, which is US$38.7 million less than the base case owner mining scenario.

Mining operating costs have been increased on average over the life of mine by US$0.56/t in this scenario to reflect:

- Recovery of the contractor's contribution to initial capital of US$10 million (as discussed above)
- Depreciation of the contractor's equipment over the life of mine
- An uplift to provide a profit to the contractor

The assumed average contract mining cost per tonne over the life of mine is $3.21/t which exceeds the average of preliminary quotes already received from contractors. This is a preliminary assumption and will be replaced by final mining contractor tenders which will be based on the DFS mine plan.

The results of the preliminary mining contractor scenario are set out in Table 16-7 and Table 16-8. This assumes an all-new processing plant and that tenders for the EPCM contractors will now proceed, to be followed by detailed engineering and procurement, which may identify opportunities for savings in infrastructure by refining civil engineering assumptions and perhaps savings by purchasing suitable second-hand plant items.

Table 16-7: Summary of Operating Cost – Contract Mining

Area	Unit	Cost
Mining costs	US$/oz	433
Processing costs	US$/oz	133
General and administrative costs	US$/oz	86
Total cash operating costs	**US$/oz**	**652**

Table 16-8: Financial Summary (post-tax) – Contract Mining

Description	Unit	Value
NPV at 8.0 % real discount rate	US$	125M
IRR (nominal)	%	27.1
Net undiscounted cash flow	US$	262M

Under the mining contractor scenario, the NPV is increased from US$118 million to US$125 million and the IRR is increased from 21.9 % to 27.1 % on an unleveraged (all-equity) basis.

The cashflow profile for the contract mining scenario is set out in Figure 16-4 .

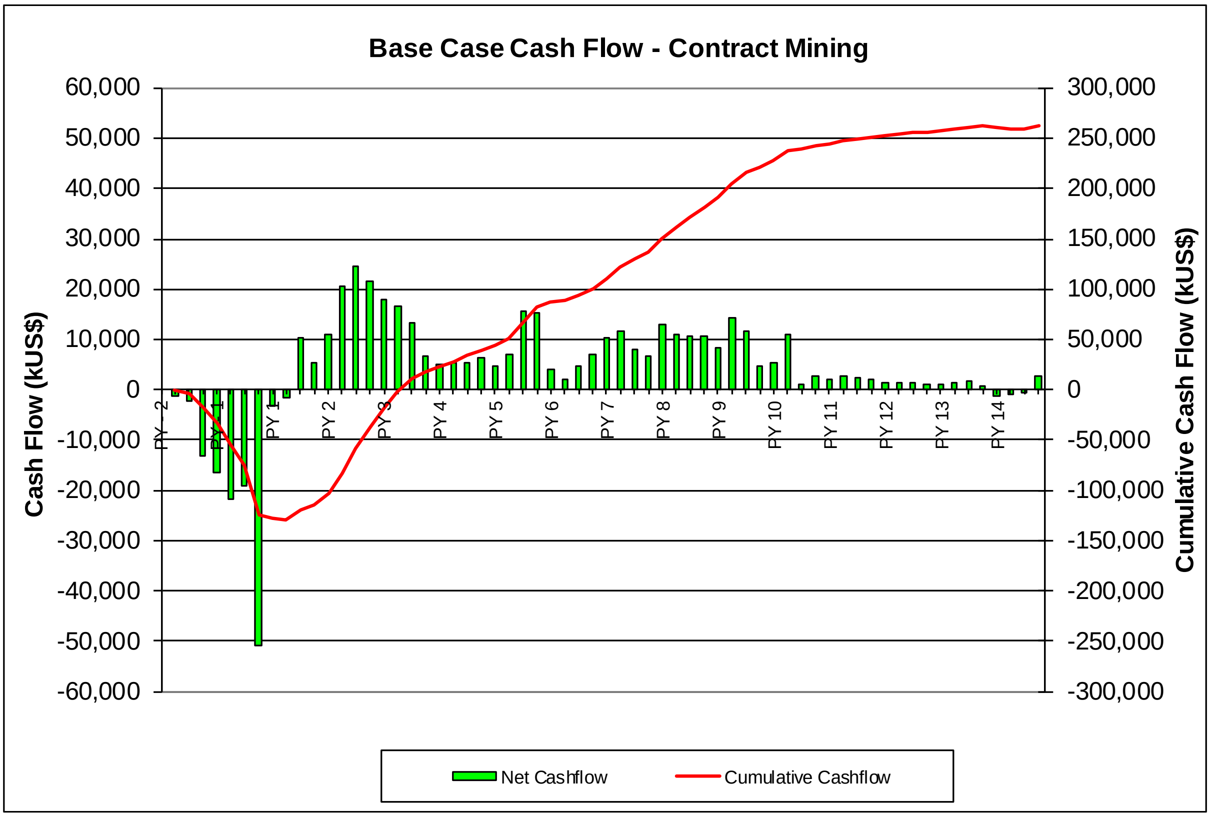

Figure 16-4: Base Case Cashflow – Contract Mining

The peak funding requirement of $129.6 million reflects the following targeted contractor retention arrangements:

- Gold production commences in the second quarter of 2017 (PY 1 in above chart) and the EPCM contractor's final payment of 10% is paid in the third quarter of 2017
- The mining contractor funds $10 million of the mining pre-strip costs and mine infrastructure costs which is claimed back through the mining rates charged during operations

Cashflow generation during the first two production quarters totals US$11.7 million and explains the difference between initial capital of US$141.3 million and the peak funding requirement of US$129.6 million.

The results of the sensitivity analysis for the mining contractor scenario are shown in Figure 16-5 and Figure 16-6 and summarised in Table 16-9, Table 16-10 and Table 16-11.

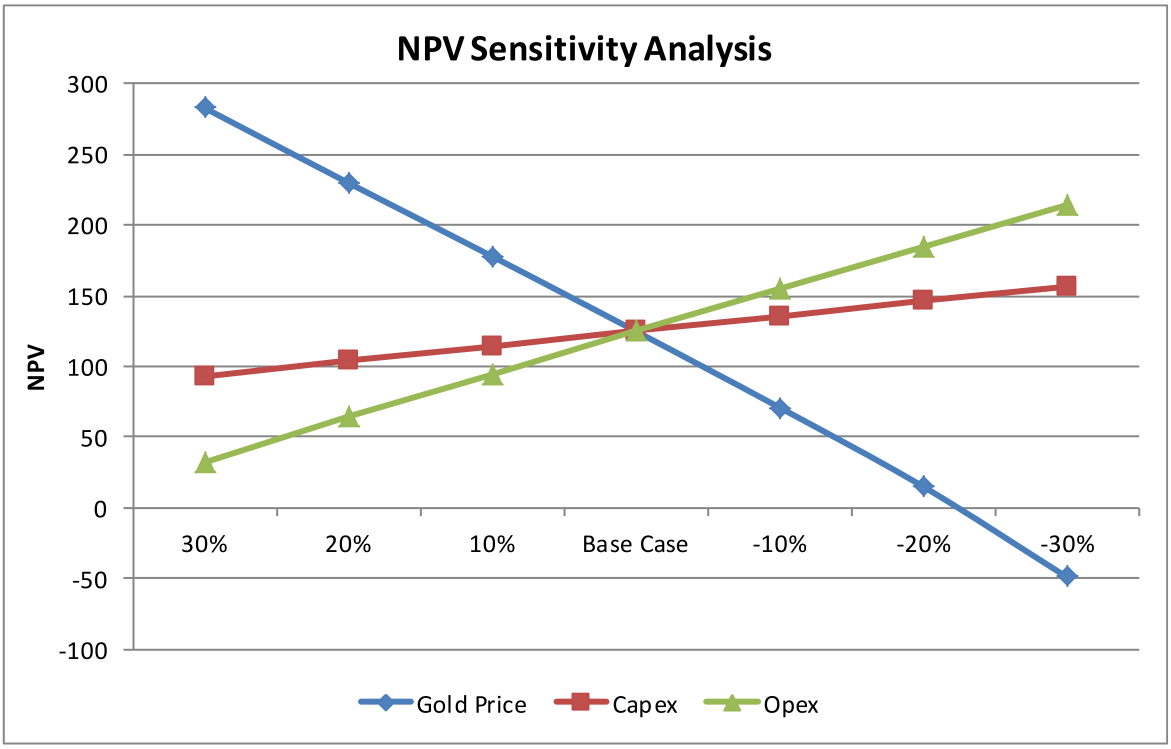

Figure 16-5: NPV Sensitivity Analysis – Mining Contractor Scenario

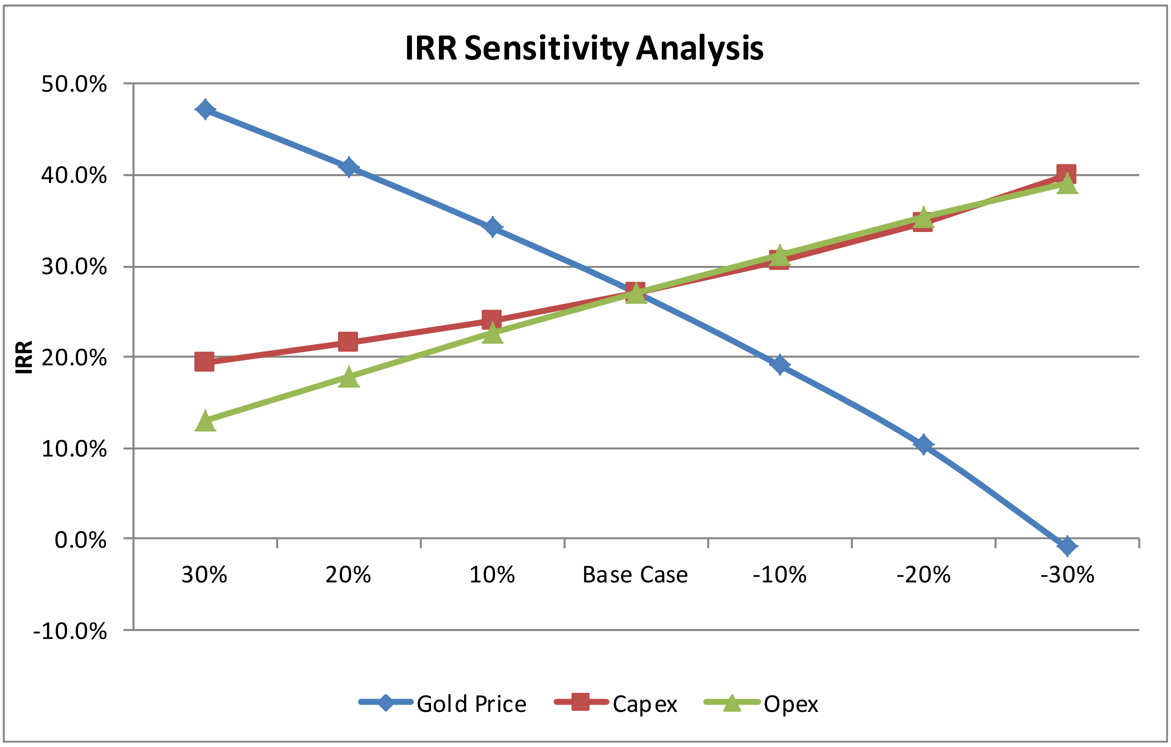

Figure 16-6: IRR Sensitivity Analysis – Mining Contractor Scenario

Table 16-9: Sensitivity to Gold Price – Mining Contractor Scenario

Option	Gold Price (US$/oz)	IRR (%)	NPV (US$M)
30 %	1 625	47.2	282
20 %	1 500	40.9	230
10 %	1 375	34.2	178
Base Case	**1 250**	**27.1**	**125**
-10 %	1 125	19.1	71
-20 %	1 000	10.3	15
-30 %	875	-0.9	-50

Table 16-10: Sensitivity to Initial Capital Costs – Mining Contractor Scenario

Option	CAPEX (US$M)	IRR (%)	NPV (US$M)
30 %	184	19.3	93
20 %	170	21.5	104
10 %	156	24.1	114
Base Case	**141**	**27.1**	**125**
-10 %	127	30.6	135
-20 %	113	34.7	146
-30 %	99	39.9	156

Table 16-11: Sensitivity Analysis to Operating Costs – Mining Contractor Scenario

Option	OPEX (US$M)	IRR (%)	NPV (US$M)
30 %	816	13.0	32
20 %	753	17.9	64
10 %	690	22.6	94
Base Case	**628**	**27.1**	**125**
-10 %	565	31.3	155
-20 %	502	35.3	185
-30 %	439	39.2	214

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SECTION 17 Health, Safety and Security

Tulu Kapi Gold Project
Definitive Feasibility Study

JULY 2015

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17.1 INTRODUCTION

KEFI Minerals Plc (KEFI) is committed to providing a safe, secure, healthy and productive workplace for all personnel, in conjunction with mitigating impact to the environment. In fulfilling this commitment, the *Health, Safety and Security (HSS) Manual* and the *Environmental and Social (ES) Manual* have been developed to provide safe operating procedures specific to worksite activities to assist KEFI in meeting its objectives for Occupational Health and Safety sustainability.

Employees, casual staff, contractors, and subcontractors are required to actively participate in making the workplace incident- and injury-free.

The Environmental Impact and Management Plans are referred to in Section 11 and therefore the environmental references in this section refer mainly to working practices and other systems that serve a common purpose and practice with health, safety and security.

KEFI also considers the effects of its activities on the community (see Section 10), highlighting its commitment to preventative measures. Additionally, this document outlines any and potential hazards posed therefrom, as well as emergency contingency plans or activities that may possibly affect the community's welfare or the environment. It also highlights KEFI's actions to ensure adequate communication of the above to such communities.

HSS are based on the belief and experience that their successful implementation is compatible with the long-term goals for commercial success. The intention is to provide a safe, secure and healthy working environment for employees, which in turn encourages and motivates those employees to work in an effective, productive, safe and healthy way, to the benefit of all.

17.2 REGULATIONS AND LEGISLATION

KEFI is committed to ensuring that all health, environment, safety and security policies and procedures will ensure compliance with the following Federal Democratic Republic of Ethiopia (FDRE) Occupational Health and Safety (OHS) Regulations and other legal chapters such as, but not limited to the following:

- Constitution (1995) – Article 42/2: Rights of Labour, specifically workers' rights to healthy and safe work environment.
- Proclamation No. 4/1995 – Powers and Duties of the Ministry of Labour and Social Affairs (MOLSA), determines the standards and measures for the safety and health of workers and follows up on their implementation.
- Proclamation No. 377/2003 – Section 3(4): Obligations of Employer, Labour Proclamation.
- Health Policy Statement (1993) – The promotion of OHS included in the priorities.
- Proclamation No. 300/2002 – Environmental Pollution Control.

Ethiopia has a policy and resources legislative framework, but no specific Regulation for the management and administration of health, safety and environment in mines.

The lack of such legislation places an obligation on the mine owner to adopt a regime of good working systems, which utilise best practices in the world's developed mining nations. Furthermore, although Ethiopia does not have any specific mining safety legislation, as a member of the UN, it assumes a general 'umbrella' of health, safety and environmental regulations that the mine must acknowledge and is morally obliged to follow.

Additional applicable Proclamations and Regulations are listed in Annexure 17-1.

17.3 POLICY STATEMENT

KEFI's Health, Safety, Environment, Labour and Community (HSEC) Policy, updated as of May 2014 states the following:

> ***KEFI Minerals Plc and its subsidiaries ("KEFI" or the "Company") are committed to the implementation of a comprehensive Health, Safety, Environment, Labour and Community (HSEC) Policy, ensuring that this policy is made known to all its directors, officers, employees and contractors and that it is proactively implemented, reviewed, and updated.***

Health and Safety (H&S), Environmental and Security policies will be reviewed every three years and more frequently if required due to business developments, operational practice improvements or changes in relevant legislation. The Company will cascade all the relevant policies through a number of integral documents, Company programmes, procedures and local operating practices.

The detailed HSEC policy is provided as Annexure 17-2.

17.4 STANDARDS

KEFI's HSS policies and procedures, specifically Health and Safety, will apply world's best practice and seek to achieve the NOSA 5 Star standard. The NOSA 5 Star system is globally proven to be one of the most effective systems for reducing workplace incidents.

KEFI will also apply world's best practice and work to achieve similar standards in the practice of Environmental Management, Risk Management, Information Security, and Energy Management.

17.5 COMMITMENTS

17.5.1 Company

KEFI will commit to the minimum of the following:

- To consider, consult, inform and educate the local community in potential hazards arising from KEFI's operations.
- To reduce to acceptable levels, or prevent, potential hazards to human life or aspects of the environment, including, water, air, animal or plant life.

17.5.2 Employer

KEFI, as the employer, will commit to the minimum of the following:

- To provide conditions for safe operations and a healthy working environment.
- To ensure the security of its personnel and subcontractors as well as the protection of their equipment.
- To ensure the provision of communications systems to achieve the above-mentioned conditions.
- To provide protective equipment and measures to ensure the safety and welfare of personnel.
- To provide suitable storage areas and emergency equipment for all site-associated concerns.
- As far as is reasonably practicable, to ensure the mine commissioning, operation, maintenance and decommissioning in such a way that personnel can perform their work without endangering the health, safety, security and environment of themselves or any other persons.
- To compile and distribute annual reports on the health, environment, safety and security of KEFI's operations.

17.5.3 Employees

The employees will comply with legal requirements and be required to follow Company Policies and Procedures beneficial to their own and other personnel's circumstances such as

- Taking reasonable care to protect their own health, safety and security.
- Taking reasonable care to protect the health, safety, and security of others.
- Using the protection equipment provided to them, wearing it correctly and maintaining it in a good condition for the most effective use.
- Following protection systems and procedures and implementing work instructions.

- Reporting promptly any identified hazard or incident to themselves, others (whether employees, visitors or community members), and/or the environment, including water, air, animal or plant life.

17.6 SYSTEMS

17.6.1 Introduction

This section summarises KEFI's Health, Safety, Environment, Labour and Community (HSEC) policy and outlines its principal objectives. At present, this comprehensive Policy is primarily aimed at exploration and development activities, however, KEFI intends for this Policy to be reviewed and updated on an ongoing basis, at appropriate times to take account of the progress and change in KEFI's operations, such that it remains relevant having regard to the stage of those operations.

HSS procedures have been developed from this and other relevant policies to ensure that the same objectives are met in an effective, timely and consistent manner.

KEFI has included an HSS System framework for full-scale operations at Tulu Kapi to correspond with KEFI's current HSEC Policy.

17.6.2 Purpose

The purpose of having HSS systems is to ensure that policy guidelines are followed and that Company commitments are achieved, through a series of processes, some of which include the provision of procedures, work instructions, emergency plans, etc. Systems ensure methodical practices that maintain consistent results; they should be logical, accurate, and realistic/achievable.

17.6.3 Scope

KEFI will develop and operate the Tulu Kapi site using the best available industry HSS practices and as such will have structured a Safety, Health and Environment (SHE) regime that includes, but is not limited to the following:

- A review of international mine regulatory frameworks
- An HSS system for the Tulu Kapi Project
- A series of site procedures and work instructions that define safe and secure systems of work for the Tulu Kapi Project operations as well as the provision within the procedures to maintain the environment

17.6.4 Systems Topics

KEFI has and will continue to develop systems, such as, but not limited to the ones given below.

17.6.4.1 Company Health, Environment, Safety and Security Plan

Outline in a written document how the business will take appropriate measures to prevent workplace criminal activities, injuries and illnesses, and to provide employees with a safe and healthy working environment.
Annually review, define and document how the requirements for the SHE systems will be met.

Set criteria for design, development, establishment, maintenance and adherence of policies, procedures, work instructions and processes to enable effective HSS systems.

Communicate relevant information, procedures and requirements to employees, contractors, service providers, visitors, community members, authorities and all stakeholders.

17.6.4.2 HSS Expectations and Performance Appraisals

Define roles and responsibilities to be established for each of the system elements, according to specific requirements.

Ensure that appointed persons are held accountable for nominated responsibilities, and that performances are measured and reviewed in annual appraisals.

17.6.4.3 Objectives and Targets

Set goals to measure the effectiveness of systems and adherence to them.

17.6.4.4 Legal and Legislative Requirements

Ensure the compliance with all the FDRE laws applicable to KEFI's activities as well as maintaining international legal standards.

17.6.4.5 Hazard and Aspect Analysis and Regulatory Compliance

Implement a process to ensure that the business has appropriately addressed all operational hazards and complied with all applicable regulations.

Establish and maintain a procedure to identify the SHE aspects of its activities. Assess risks of identified hazards and implement controls.

Ensure that the hazards and aspects related to significant risks and impacts are considered when setting SHE standards and in the maintenance of effective objectives.

17.6.4.6 Employee Involvement

Create a culture in which employees have ownership of and participate actively in the Company's SHE programmes and ensure that SHE is a priority agenda item at meetings and in employee communications.

17.6.4.7 HSS Specialist

Designate the individual(s) responsible for assisting management in implementing the company HSS systems.

17.6.4.8 Accident Reporting

Identify the root causes of incidents, accidents, injuries and illnesses; ensure the implementation of corrective actions via change to equipment, work procedures and training programmes, etc.

17.6.4.9 Training

Provide employees with the knowledge and skills needed to perform work safely and in compliance with regulatory requirements.

Provide job skills and capability expansion training programmes.

17.6.4.10 Inspections and Evaluations

Conduct regular evaluations of the work and surrounding environment to detect unsafe, unhealthy and insecure conditions.

Evaluate competency, abilities and knowledge of HSS systems.

Audit the relevance and effectiveness of systems.

Ensure the effectiveness of equipment.

Monitor the effects of operations on people, local community and staff, as well as the environment.

17.6.4.11 Personal Protective Equipment (PPE)

Provide and ensure the use of appropriate clothing and devices to protect against hazards in the work environment. PPE includes respirators, skin protective and high visibility clothing, head, ear, hand and foot protection, specialist air oxygen supply units, and other specialised equipment needed for site-specific hazards.

17.6.4.12 Contractor SHE

Establish safety procedures and effective environmental practices for contractors to protect KEFI employees, contractors and the local community, as well as air, water, animal and plant life.

17.6.4.13 Emergency Response Plans (ERPs)

Establish plans for responding to actual and potential emergencies in coordination with all KEFI's designated emergency services staff, local emergency services, and local emergency response officials.

ERPs will cover the procedures for the following:

- To eliminate or control hazards
- To evacuate to prevent (further) injuries
- To escape to safety
- To communicate emergency situations to management, staff, contractors, visitors, communities, emergency services and authorities alike
- To rescue, retrieve and provide medical care
- To recover from emergency situations and to return to normal operations

Regularly test and evaluate emergency preparedness, equipment suitability, and training.

17.6.4.14 Job Analysis

Analyse the steps of each job or task to identify hazards and risks as well as defining preventative measures to avoid employee illness or injury.

17.6.4.15 Resource Plans

Ensure that management provides appropriate resources, including human, technological and further facilities essential to the implementation of the HSS systems.

Use outside specialists and equipment to assist, evaluate or complete systems.

17.6.4.16 Promotion of Working Systems

Encourage good working practices and adherence to HSS systems, through reward and recognition.

17.6.4.17 Communicate

KEFI will communicate the following to all employees and contractors:

- New developments in policies, procedures, work instructions and processes
- Changes of events to all parties with a vested interest or to all parties who are directly or indirectly affected.

17.6.4.18 Management and Discipline

Oversee and enforce systems, as well as providing deterrents for malpractice, through discipline measures.

17.6.4.19 SHE Review of New and Modified Facilities and Equipment

Review plans and design specifications of facilities and equipment before construction, purchase or operational use.

17.6.4.20 Corrective and Preventative Methods

Carry out daily inspections prior to use of equipment. Clean, fuel, and lubricate equipment and secure or correctly store equipment. Adjust components and items to ensure that they work correctly.

Carry out preventative maintenance inspections and schedules. Notify management of issues and how to prevent them.

17.6.4.21 Industrial Health Hazards

Recognise, evaluate and control health risks to employees caused by chemical, biological and physical agents in the work environment.

17.6.4.22 Clean Culture

Encourage high standards of personal hygiene.

Promote good housekeeping practices and the correct disposal of waste.

Provide facilities to maintain cleanliness; collect and dispose of waste.

17.6.4.23 Chemical Management

Manage the ordering, procurement, storage, distribution and use of chemicals to minimise exposure and health risks to employees.

17.6.4.24 Ergonomics

Design jobs and workplaces to minimise the possibility of physical harm from repetitive motions and heavy lifting, and to foster increasing productivity.

17.6.4.25 Mobile Equipment Safety

Establish procedures to reduce risk of accident or injury by selecting appropriate vehicles, and providing maintenance and ensuring qualified operators for such vehicles. These procedures will also include the following:

- Separating pedestrians from machinery
- Providing suitable signage, demarcation areas, audible and visual warning devices

17.6.4.26 Medical Services

Ensure that Occupational Medical Services are provided for the mine and that their role is incorporated into the overall business programme.

Provide services to treat and stabilise patients for further evacuation when required.

17.6.4.27 Monitoring

Measure the effectiveness of each system element and related activities, as well as identifying the next steps for continuous improvement.

17.6.4.28 Record Keeping

Maintain accurate and current records, archive records securely and for the statuary amount of time.

17.6.4.29 Lockout Procedures

Prescribe the use of lockout devices and other methods to control the unexpected energising, start up or release of stored energy from machines or equipment that could cause injury to employees during servicing and maintenance.

17.6.4.30 Third-Party Risks

Control the risks involved in utilising leased or hired plant, equipment, machinery, services, buildings, transport, ships, aircraft, etc.

17.6.4.31 Emissions Control

Ensure the minimum air pollution, water contamination and discharge volumes in compliance with statutory requirements, so as not to present health and environmental issues within the local community.

17.6.4.32 Waste Control

Ensure that the minimum amount of waste is generated and that all waste is controlled and audited during storage and disposal.

Choose products that are non-harmful or the least harmful, to reduce the amount of contaminated waste and the need for further waste due to protective or responsive products.

17.7 PROCEDURES AND WORK INSTRUCTIONS

Under the various legislations applicable to KEFI's operations at Tulu Kapi, whether FDRE or international, it is required that the Company establish, implement and maintain various health, safety, security and environment procedures, otherwise known as Standard Operating Procedures (SOPs), that regulate the manner in which the Company operates. SOPs are developed in the training packages as outlined in Section 8 (Manpower and Training). SOPs are a commitment to the appropriate Company policy and constitute part of the policy that may be reviewed on a more regular basis.

HSS procedures are written to ensure that the construction of the mine and the subsequent mine operations, operate in compliance with applicable environmental, health and safety regulations, and that appropriate measures are in place to prevent workplace injuries and illnesses, providing employees with a safe, secure and healthy working environment.

17.7.1 Purpose

The purpose of an SOP is to define the systematic process of an operational activity in its most effective standard method. From this more specific work instructions can be designed, applied and carried out.

17.7.2 Scope

Procedures and work instructions relate to all activities within KEFI's operations and apply to all management, employees and subcontractors. KEFI standards are measured by the effectiveness of these procedures and work instructions and the adherence to them.

17.7.3 Content and Establishment Process

The SOP is the overview, the general procedure (with a purpose, scope, definitions and procedures themselves), as well as the required documentation. Work instructions are similar (with the same headings) but consist of a very specific step-by-step process of how the work is to be carried out.

The content for each SOP is based on the requirements of an activity, and the identification of how such activity should be carried out effectively and correctly, as well as safely. The wording should not be ambiguous; it should be simple and definitive:

- Who will do it?
- What will be done?
- When will it be done?
- How will it be done?
- With what will it be done? (equipment, tools, etc.)

It will also identify any chain of command requirements, and the roles and responsibilities of identified personnel.

The SHE Committee will discuss the information with the operators and relevant department management to establish the content. They will then draft and submit the procedure to the HSS Management, who in turn will make any required additional changes to the final draft, for approval by the Managing Director. If approved, the Managing Director will have the SOP or work instruction signed off by the Senior Management.

17.7.4 Production and Publication

Once established as an effective procedure or working instruction, it will be added to the SOP Manual and notification of its existence and awareness training on its content will be given to end users.

17.8 ROLES AND RESPONSIBILITIES

17.8.1 Purpose

Section 8 (Manpower and Training) defines the line management structure detailing the persons responsible for the following:

- Ensuring that progress is made towards establishing, implementing and maintaining HSS management systems and procedures in accordance with the accepted OHS standards
- Reporting on the performance of the HSS management systems and procedures to management for review and continual improvement

This section covers the identification and definition of the responsibilities for the management of HSS systems within the line management structure of the Company.

17.8.2 Scope

All KEFI personnel and their contractors are responsible for Health, Environment, Safety and Security, each person ensuring that they are working correctly and with due consideration to ensure their safety and that of others. Authority is given to certain KEFI Managers and personnel to ensure that all employees and contractors are kept safe, secure and healthy.

This section highlights the common requirements of allocated positions, departments and groups and is not an exhaustive list of roles and responsibilities. Further responsibilities have been detailed in later sections, and within the appropriate manual, that are more specific to the subject matter, but they still do not constitute a complete list of all requirements.

17.8.3 General

17.8.3.1 Managing Director

Roles and Responsibilities:

- Impose, endorse and commit the Company to the HSS Policies.
- Be accountable for HSS matters at Tulu Kapi.

Obligation:

- Provide resources essential to the implementation and control of the HSS management systems, including human, technological and financial resources.
- Define the line management responsibilities.

- Define the membership of the Mine Health and Safety (H&S) Committee (Employee representation from the SHE Committee and the Employer's representative).
- Monitor the HSS management performance of the HSS team.

Delegation:

- Oversee the design, content, establishment, implementation and maintenance of working instructions.
- Ensure that an adequate level of HSS advice and support is available to the business, commensurate with its needs and risk exposure.
- Ensure that HSS considerations are integrated with business decisions that could have an effect on risk exposure.
- Ensure the third-party agreement and availability of support and services to emergency plans.
- Ensure that effective processes are in place to support ongoing HSS meetings to support the development of a safe, secure and healthy culture at KEFI sites.

Communication:

- Report all HSS matters to Senior Management.
- Communicate all new and amended Company policies.

17.8.3.2 General Managers

Roles and Responsibilities:

- Senior staff at this level are accountable for the line managers who report to them and should monitor their performance against the expectations below
- It is essential that management establish effective delegation arrangements and implement corporate and Company policy. This includes co-operation with the SHE function and monitoring their staff performance against specific targets and requirements.

Obligation:

- Ensure operational effectiveness in line with a safe, secure and healthy environment.
- Ensure the design, content, establishment, implementation and maintenance of procedures and working instructions.

Delegation:

- Ensure the carrying out and documentation of daily toolbox meetings for their workers; participating in safety meetings as required.

- Ensure the adherence to all Company procedures and working instructions.
- Ensure the correct qualification, licence, training and continued assessment of mobile and motorised equipment users prior to equipment use.
- Ensure the correct warning devices and clearance procedures for the operation of equipment.
- Ensure the correct wearing of appropriate PPE.
- Ensure that qualified personnel follow the correct lockout procedures in the maintenance of equipment.
- Correct unsafe conditions.

Communication:

- Report any identified hazards and risks.
- Communicate all new and amended Company procedures.

17.8.3.3 Line Management and Site Representatives

Roles and Responsibilities:

- Be responsible for all HSS concerns in their department.
- Be responsible for all personnel whom they manage.

Obligation:

- Enforce the implementation and continuance and adherence to Company procedures and working instructions.
- Actively participate in accident, injury and illness and pollution prevention activities.
- Ensure that routine inspections are carried out.
- Frequently review SHE performance of their area, personnel and contractors against established objectives and goals.
- Investigate all significant incidents that resulted, or could have resulted in injury, property/equipment damage or release of pollutants.
- Demonstrate commitment to SHE.
- Make safety a priority in daily activities.
- Participate in company SHE activities.

Delegation:

- Ensure that job-specific safety procedures are established as ascertained by risk assessments.
- Ensure the training of employees in safe working practices.
- Ensure the correct qualification, licence, training and continued assessment of mobile and motorised equipment users prior to equipment use.

- Ensure the correct warning devices and clearance procedures for the operation of equipment.
- Ensure the correct wearing of appropriate PPE.
- Ensure that qualified personnel follow the correct lockout procedures in the maintenance of equipment.
- Ensure the correction of unsafe conditions.
- Communicate relevant SHE information to employees.
- Ensure the effective and timely training on SHE procedures.
- Promote and facilitate employee involvement in SHE activities, e.g. inspections, safety committees, and conducting daily toolbox meetings for their department.
- Reinforce the SHE culture through disciplinary actions and positive recognition programmes.
- Arrange effective supervision of all company employees, contractors and activities at all workplaces.

Communication:

- Report any identified hazards and risks.
- Report any corrected conditions or any conditions unable to be corrected.
- Report all significant incidents that resulted or could have resulted in injury, property/equipment damage or release of pollutants.
- Communicate relevant SHE information to employees.

17.8.3.4 Support Management and Superintendents

Roles and Responsibilities:

- Be responsible for all HSS concerns in their department.
- Be responsible for all personnel whom they manage.

Obligation:

- Enforce the implementation, continuance and adherence to Company procedures and working instructions.
- Actively participate in accident, injury, illness and pollution prevention activities.
- Ensure that routine inspections are carried out.
- Frequently review SHE performance of their area, personnel and contractors against established objectives and goals.
- Investigate all significant incidents that resulted or could have resulted in injury, property/equipment damage or release of pollutants.
- Demonstrate commitment to SHE.
- Make safety a priority in daily activities.
- Participate in Company SHE activities.

Delegation:

- Ensure that job-specific safety procedures are established as ascertained by risk assessments.
- Ensure the training of employees in safe working practices.
- Ensure the correct qualification, licence, training and continued assessment of mobile and motorised equipment users prior to equipment use.
- Ensure the correct warning devices and clearance procedures for the operation of equipment.
- Ensure the correct wearing of appropriate PPE.
- Ensure that qualified personnel follow the correct lockout procedures in the maintenance of equipment.
- Ensure the correction of unsafe conditions.
- Communicate relevant SHE information to employees.
- Ensure the effective and timely training on SHE procedures.
- Promote and facilitate employee involvement in SHE activities, e.g. inspections, safety committees, and conducting daily toolbox meetings for their department.
- Reinforce the SHE culture through disciplinary actions and positive recognition programmes.
- Arrange effective supervision of all company employees, contractors and activities at all workplaces.
- Ensure the availability of PPE in suitable numbers and of legislative standard.
- Ensure the availability of associated cleaning products for PPE and general hygiene.
- Ensure the availability of potable (in line with Environmental procedures) and non-potable water.
- Ensure the availability of clean accommodation.
- Ensure the availability of hygienic and correctly prepared food.
- Ensure the availability of sanitised ablutions.
- Ensure the availability of fuel for emergency vehicles.
- Ensure the maintenance and roadworthiness of emergency vehicles.
- Ensure the maintenance of all machinery.

Communication:

- Report any identified hazards and risks.
- Report any corrected conditions or any conditions unable to be corrected.
- Report all significant incidents that resulted or could have resulted in injury, property/equipment damage or release of pollutants.
- Communicate relevant SHE information to employees.

17.8.3.5 Employees and Contractors

Roles and Responsibilities:

- To carry out all duties correctly and with due care and attention.

Obligation:

- Know and follow established job-specific SHE procedures and rules.
- Know and follow all Company procedures and working instructions.
- Ensure the correct use of warning devices and clearance procedures for the operation of equipment.
- Ensure the correct wearing of appropriate PPE.
- Ensure that qualified personnel follow the correct lockout procedures in the maintenance of equipment.
- Maintain the highest housekeeping standards in work area.
- Maintain all SHE equipment in good working order.
- Actively participate in SHE training.
- Actively participate in daily toolbox meetings.
- Constantly demonstrate competency based on training received.
- Actively participate in accident, injury and illness prevention activities.
- Actively participate in the resulting investigations of any accident, injuries or illnesses.
- Implement known regulatory compliance requirements in their work area, e.g. wearing personal protective equipment.

Communication:

- Identify and correct hazards and unsafe acts and conditions, within their control.
- Bring SHE issues, unsafe actions and safety suggestions to the attention of management.
- Immediately report all accidents, near-miss accidents and potential hazards.
- Provide suggestions for the SHE improvement programme.

17.8.4 Environmental and Social (ES) Department – Roles and Responsibilities

The ES Department will ensure that all KEFI policies are adhered to and that all legislative requirements under the ES responsibilities are fulfilled.

17.8.4.1 Environmental and Social Manager

Roles and Responsibilities:

- Impose, endorse and commit the Company to the ES working instructions.

- Be responsible for Environmental matters at Tulu Kapi.

Obligation:

- Promote the Company's Environmental Procedures.
- Ensure the design, content, establishment, implementation and maintenance of Environmental Procedures and working instructions.
- Provide technical leadership of the Company's Environmental procedures and working instructions, as well as processes.
- Ensure that an adequate level of Environmental advice and support is available to the business, commensurate with its needs and risk exposure.
- Ensure that Environmental considerations are integrated with business decisions that could have an effect on risk exposure.
- Monitor the performance of the Environmental Team.
- Ensure that effective processes are in place to support ongoing Environmental meetings to support the development of a safe, secure and healthy environment at KEFI sites.
- Represent the Company on Environmental issues to the FDRE authorities, suppliers, contractors and all other stakeholders. This includes fostering effective and beneficial relationships and maintaining the Company's professional image.
- Ensure continual assessments, testing, evaluation and monitoring of existing or proposed policies, procedures or working instructions.
- Carry out and test emergency Environmental plans.
- Investigate, collate, assess, report and recommend on all Environmental matters.
- Identify aspects, analyse risks and promote controls for a healthy environment.
- Carry out inductions for all employees and contractors periodically on Environmental issues.
- Carry out inductions on Environmental issues for newcomers and visitors to site immediately on their arrival at site.
- Maintain records of all incidents and assess and recommend preventative/corrective measures.

Delegation:

- Ensure that appropriate systems are in place for the safe and secure management of all activities at KEFI worksites, overseeing Environmental requirements in preventative and reactive designs and structures.
- Ensure that effective processes are in place to enable regular SHE meetings to support the development of a healthy environment at KEFI sites.
- Ensure that Environmental requirements are incorporated into training initiatives.
- Ensure continued Environmental training and awareness.
- Ensure the testing and maintenance of all Environmental emergency equipment.
- Ensure compliance with good working practices; conducting monthly potability testing of the water source.

- Ensure the management of daily treatment, testing and documentation of the drinking water, maintaining acceptable levels in line with KEFI commitments and legislative requirements.
- Ensure the management of daily testing and documentation of local water sources, maintaining acceptable levels in line with KEFI commitments and legislative requirements.
- Ensure the management, testing and recording of air quality standards maintaining acceptable levels in line with KEFI commitments and legislative requirements.
- Ensure the management, testing and recording of noise quality standards maintaining acceptable levels in line with KEFI commitments and legislative requirements.
- Ensure the maintenance of records of all Environmental incidents, and assess and recommend preventative/corrective measures.

Communication:

- Report all Environmental matters to the HSS Manager.
- Communicate all new and amended Company procedures.
- Provide strategic and, where necessary, detailed advice to directors and managers.
- Comment on, and help approve potential expenditure or plans with an Environmental impact.
- Monitor company Environmental performance and report to the management team at regular intervals.
- Ensure the correct placing and use of obligatory Environmental awareness signs.

17.8.5 Health, Safety and Security (HSS) Department – Roles and Responsibilities

The purpose of the HSS Department is to ensure that all KEFI policies are adhered to and that all legislative requirements under the HSS responsibilities are fulfilled:

- Ensuring the establishment, implementation and maintenance of HSS management systems, procedures and work instructions in accordance with company policy, legal requirements and company set standards.
- Reporting on the performance of all HSS systems and procedures to KEFI for review and continual improvement.

17.8.5.1 HSS Manager

Roles and responsibilities:

- Impose, endorse and commit the Company to the HSS Procedures.
- Be responsible for HSS matters at Tulu Kapi.

Obligation:

- Promote the Company's HSS Policies.
- Ensure the design, content, establishment, implementation and maintenance of HSS procedures.
- Provide technical leadership of the company's HSS policy and procedures.
- Ensure that an adequate level of HSS advice and support is available to the business, commensurate with its needs and risk exposure; and
- Ensure that HSS considerations are integrated with business decisions that could have an effect on risk exposure.
- Monitor the performance of the HSS team.
- Ensure that effective processes are in place to support ongoing HSS meetings to support the development of a safe, secure and healthy culture at KEFI sites.
- Represent the company on technical HSS issues to the FDRE authorities, suppliers, contractors and all other stakeholders. This includes fostering effective and beneficial relationships and maintaining the Company's professional image.
- Ensure independent auditing on a set regular basis (minimum two years).
- Prepare and test emergency plans.

Delegation:

- Ensuring that appropriate systems are in place for the safe and secure management of all activities at KEFI worksites, overseeing HSS and Fire requirements in preventative and reactive designs and structures.
- Monitor company SHE performance and report to the management team at regular intervals.
- Ensure continual assessments, testing, evaluation and monitoring of existing or proposed policies, procedures or working instructions.
- Ensure the correct qualification, licence, training and continued assessment of equipment users prior to equipment use.
- Ensure the correct warning devices and clearance procedures for the operation of equipment.
- Ensure the correct wearing of appropriate PPE.
- Ensure that qualified personnel follow the correct lockout procedures in the maintenance of equipment.
- Ensure continual assessments and monitoring of existing or proposed structures.
- Ensure continual assessments and monitoring of existing or proposed machinery or mobile equipment.
- Ensure that effective processes are in place to enable regular SHE meetings to support the development of a safe, secure and healthy culture at KEFI sites.
- Ensuring the establishment and implementation of employee and employer representation through Committees.

Communication:

- Report all HSS matters to the Managing Director.
- Communicate all new and amended Company procedures.
- Provide strategic, and where necessary, detailed advice to directors and managers.

17.8.5.2 Security Superintendent

Roles and responsibilities:

- Impose, endorse and commit the Company to the HSS working instructions.
- Be responsible for Security matters at Tulu Kapi.

Obligation:

- Promote the Company's Security Procedures.
- Ensure the design, content, establishment, implementation and maintenance of Security procedures and working instructions.
- Provide technical leadership of the Company's Security procedures and working instructions, as well as processes.
- Ensure that an adequate level of Security advice and support is available to the business, commensurate with its needs and risk exposure.
- Ensure that Security considerations are integrated with business decisions that could have an effect on risk exposure.
- Monitor the performance of the Security Team.
- Ensure that effective processes are in place to support ongoing Security meetings to support the development of a safe, secure and healthy culture at KEFI sites.
- Represent the Company on technical Security issues to the FDRE authorities, suppliers, contractors and all other stakeholders. This includes fostering effective and beneficial relationships and maintaining the Company's professional image.
- Ensure continual assessments, testing, evaluation and monitoring of existing or proposed policies, procedures or working instructions.
- Carry out and test emergency Security plans.
- Investigate, collate, assess, report and recommend on all Security matters.
- Identify aspects, analyse risks and promote controls for healthy environment.
- Carry out inductions for all employees and contractors periodically on Security issues.
- Carry out inductions on Security issues for newcomers and visitors to site immediately on their arrival at site.
- Ensure that Security systems prevent unauthorised access to KEFI sites.
- Ensure that there are Security systems for the protection of information.
- Ensure that there are security systems to protect KEFI personnel and contractors.
- Maintain records of all incidents, and assess and recommend preventative/corrective measures.

Delegation:

- Ensure that appropriate systems are in place for the safe and secure management of all activities at KEFI worksites, overseeing Security requirements in preventative and reactive designs and structures.
- Control access to KEFI sites and sensitive areas therein.
- Ensure the deterrence, detection and reaction to any unauthorised personnel on site.
- Ensure that Security requirements are incorporated into training initiatives.
- Ensure continued Security training and awareness.
- Ensure the testing and maintenance of all Security emergency equipment.
- Ensure the maintenance of records of all Security incidents, and assess and recommend preventative/corrective measures.

Communication:

- Report all Security matters to the HSS Manager.
- Communicate all new and amended Company procedures.
- Provide strategic, and where necessary, detailed advice to directors and managers.
- Comment on, and help approve potential expenditure or plans with a Security impact.
- Monitor company Security performance and report to the management team at regular intervals.
- Ensure the correct placing and use of obligatory Security warning signs.

17.8.5.3 Paramedic

Roles and Responsibilities:

- Oversee practical medical and health issues, awareness and training on site of all employees.

Obligations:

- Ensure the treatment of employees in a medical emergency.
- Oversee the health of the employees.
- Ensure that health awareness and training programmes are carried out.
- Test medical emergency plans.

Communication:

- Report all incidents to the HSS Manager.

17.8.6 HSS Supporting Positions and Groups

In order to provide a fair system of employee and employer representation, and to fulfil legislative requirements, groups and representatives will be established by KEFI to support the HSS systems. The representatives and groups will be elected by their peers and, along with their normal duties, will form part of the HSS systems and processes.

17.8.6.1 Safety Officer

Identified individuals will be nominated or appointed to coordinate SHE standards as Champions. They will

- Represent employees on all facets of SHE.
- Identify potential/actual hazards.
- Attend SHE meetings.
- Carry out additional SHE f unctions as agreed by their line manager/director and SHE superintendent:
    - Typical tasks include participation and assistance in accident investigation and reporting, local SHE audits, risk assessments, and circulation of SHE information.
- Receive SHE training.

17.8.6.2 Environmental Coordinator

Identified individuals will be nominated or appointed to coordinate environmental standards as Champions. They will, on a day to day basis,

- Represent employees on all facets of environmental standards.
- Identify potential/actual hazards to the environment.
- Attend HSS meetings.
- Carry out additional ES functions as agreed by their line manager/director and ES superintendent;
- Receive Environmental management training.

17.8.7 Mine Health and Safety Committee

Representatives from the Company, identified by the Managing Director, along with employee representatives from the SHE Committee will form the Mine H&S Committee. They will

- Review and update the H&S Policy.
- Choose the Chairman of the Mine H&S Committee on a rotational basis.
- Meet on a quarterly basis to review Company H&S performance.

- Ensure that the H&S Policy is communicated throughout the Company.
- Conduct Management Reviews of the Company's H&S Management System.
- Agree to the content, establishment and implementation of H&S Procedures and working instructions.
- Report on the performance of the H&S Management System to the Board.
- Ensure correct legislative ratio of SHE representatives to employees.

17.8.8 Safety, Health and Environmental (SHE) Committee

The SHE Committee will

- Conduct monthly SHE meetings.
- Select a Chairman of the committee.
- Represent employees on all aspects of SHE.
- Participate in consultations on SHE matters.
- Participate in the collation of content, establishment and implementation of SHE procedures and working instructions.
- Invite end users of procedures and working instructions for consultation.
- Agree on additional qualifications or functions of SHE representatives.
- Conduct reviews of the Company's SHE Management systems, along with site inspections on a monthly basis.
- Record and report SHE meeting agenda and action points.
- Ensure correct legislative ratio of representatives to employees.
- Collect and analyse information regarding the performance of the SHE Management System.
- Report on the performance of the SHE Management System to the Mine H&S Committee.

17.8.8.1 First Aiders

Identified by their line managers on a voluntary basis, they will

- Attend to any injured person(s) as the first responder.
- Assist paramedics in dealing with any injured personnel.
- Participate in testing and evaluation of emergency medical procedures.
- Participate in continuation training at KEFI sites.
- Attend First-Aid courses.
- Maintain First-Aid Skills and Certification requirements.

17.9 HAZARD AND ASPECT IDENTIFICATION

17.9.1 Purpose

To be able to ensure the identification of any and all hazards, which are deemed as an exposure to danger by source, situation or act, deliberate or by omission, that have the potential for harm, injury and ill health to employees, contractors and members of the community. Hazards also include identified aspects of KEFI's operational activities, services or products that interact with the environment

17.9.2 Scope

KEFI will continually inspect systems, equipment and working practices of all KEFI Management and employees, as well their subcontractors, whose activities require assessment in order to identify hazards and aspects, to allow a systematic assessment of the risk associated with them.

17.9.3 Hazard Types

17.9.3.1 Physical Hazards

Physical hazards arise from the general working environment and include but are not limited to the following:

- Noise
- Vibration
- Hazardous processes:
  - Uneven surfaces
  - Working at heights
  - Working near open water
  - Working in confined spaces, etc.

17.9.3.2 Biological Hazards

Biological hazards are viruses and bacteria and can be delivered as follows:

- Waterborne diseases
- Vector-borne diseases
- Food-borne diseases

Employee education and training on disease prevention is to be implemented as a preventative measure, whenever possible, once a risk of disease has been identified through the assessment process.

Community and Social programmes (outlined in Section 11,) will also assist in the awareness and confinement of such hazards.

17.9.3.3 Chemical Hazards

Chemical hazards are hazardous substances at the workplace and surrounding areas such as

- Acids
- Solvents
- Flammable substance

They also include fumes, gases and dust arising from such materials.

17.9.3.4 Mechanical and Electrical Hazards

Mechanical and electrical hazards arise from machinery and equipment such as

- Lifts
- Conveyer belts
- Electrical hand tools
- Portable electrical equipment

Electrical hazards are of particular concern due to their often undetectable nature (they cannot be seen or heard), and the fact that they can be fatal. Conductive materials are also of particular concern when dealing with electrical components.

17.9.3.5 Ergonomic Hazards

Hazards that arise from worker machinery interface including

- Manual handling
- Repetitive movement
- Poor design
- Restricted space
- Out-dated technology, etc.

17.9.3.6 Psycho-Social Hazards

Hazards that arise from social or work culture condition such as

- Shift work
- Peer pressure
- Harassment

- Alcohol/drug misuse

17.9.3.7 Behavioural Hazards

Hazards that arise from worker behaviour or attitude, including

- Unsafe acts or acts of omission
- Reckless and unsafe behaviour
- Overconfidence, etc.

17.9.3.8 Environmental Hazards

Hazards that arise from KEFI's interaction with the environment, such as

- Water contamination
- Air pollution
- Hazardous waste
- Resource utilisation

17.9.3.9 Explosives

Specific to mine operations is the use of explosives. Hazards arising from the use of explosive include

- Unplanned detonation, caused by
    - Degradation
    - Poor handling, etc.
- Shrapnel/flying debris
- Land collapse, etc.

17.9.3.10 Criminal Activities and Behaviour

Hazards that arise from activities of a criminal nature:

- Theft
- Criminal Damage
- Assault
- Terrorist Activities
- Organised Crime, etc.

17.10 RISK AND HAZARD ASSESSMENT

17.10.1 Purpose

To assess the level of risk of a hazard or aspect, to evaluate its severity and occurrence, probability of injury or change to the environment (whether adverse or beneficial) and to evaluate, prioritise and recommend appropriate controls that would eliminate or minimise the risk to an acceptable level at all KEFI projects through a systematic examination of worksite activities.

17.10.2 Scope

KEFI will continually assess hazards and aspects, through schedules of inspections, maintenance and testing. The assessments will be

- Systematic – with clear and procedural methodology
- Rigorous – consistent and reasonable
- Structured – in a format that is easy to use, understandable and logical
- Repeatable – can be reapplied to most hazards with similar results
- Consultative – reviewed by the users of a system and group evaluation

Hazard Identification Risk Assessment (HIRA) is the international standard used for identifying hazards and aspects, and assessing their risk. It is a systematic method that is recognisable to industry members and maintains a logical degree of results.

The assessment will quantify the risk from identified hazards, which will enable the prioritising of low and high associated risks. The assessment will also identify suitable, available controls and the value of their use in reducing the risk to acceptable levels.

17.10.3 Process

The process involves the following:

- Planning – Preparation of the scope and methodology of the assessment, along with any required resources, including time and personnel, and identifying roles and responsibilities.
- Process Mapping – Identifying activities of employees and subcontractors in their operational duties. Placing the activities into a logical sequence of steps, identifying inputs, (the raw materials used for the activity step, such as labour and tools) and the outputs, (the result of the activity, such as the product or waste).
- Identification of Hazards – Identifying hazards through direct reporting of incidents, assessment of working areas, reviews of previous incidents, as well as any changes in legislation or installation of more advanced equipment.

- Analysing and Evaluating Risk – Quantifying the risk of the hazards such as
    - Job Safety Analyses are performed by each department supervisor at the commencement of a project, or whenever a new task is undertaken, specific to the work activities of the department.
    - All identified risks are assessed based on their maximum reasonable consequences.
    - All identified risks are assessed for the probability of their occurrence.
    - Following the determination of consequence and probability, the risk level is calculated as follows:

      Risk level = Likelihood × Consequence

- Identifying Controls.

17.11 CONTROLS

17.11.1 Purpose

To identify and implement controls to reduce the risk of any hazard or aspect to an acceptable level at all KEFI projects.

17.11.2 Scope

KEFI will identify, implement and maintain controls that allow operational effectiveness along with a safe, secure and healthy working environment.

17.11.3 Control Types

17.11.3.1 Elimination/Substitution

This is any control that eliminates the hazard or aspect completely by removal, replacement or redesign, such as the replacement of hazardous substances by harmless or less hazardous substances wherever possible.

17.11.3.2 Engineering

These are controls created or supported by equipment that significantly reduces the risk level of a hazard or aspect at its source, such as

- Isolation
- Dampening
- Guarding
- Automated systems

17.11.3.3 Administrative

This is any control that mitigates the risk of a hazard or aspect through procedures, work instructions, training, education (hygiene standards, etc.), including (SANS 1186,) symbolic safety signs:

- Green – Informative
- Blue – Mandatory
- Orange – Electrical hazard
- Yellow (Yellow and Black) – Warning
- Red – Danger
- White background:
  - With black activity picture and red circle and strike through – Prohibited
  - With red activity picture – Fire (informative)

It also includes the maintenance of records such as checklists and materials safety data sheets (MSDS).

17.11.3.4 Personal Protection Equipment (PPE) and Standards

In addition to the previous controls that have been identified and implemented to reduce the risk from a hazard or aspect, the use of the PPE give below fulfils the acceptable criteria of the OS&H Authority of the FDRE, as well as international standards:

Safety Footwear

Footwear selected for toe protection, metatarsal protection, di-electric protection (or any combination of these), with a puncture-resistant sole, will comply with at least one of the following standards:

- CSA Z195-2009, *Protective footwear*.
- ANSI F 2412, *Test methods for foot protection.*
- ANSI F 2413, *Specification for performance requirements for protective footwear.*

Where applicable, they can also protect against wet climate and water saturation.

Leg Protection

Where appropriate, personnel will wear leg protective devices/shielding to protect them from lower limb injuries.

Hand Protection

Appropriate hand protection will be worn where the following hazards are identified:

- Operations involving contact with rough, sharp or jagged surfaces
- Contact with or splashes from hot, corrosive or toxic substances
- Working with vibratory machines, such as pneumatic drills
- Electrical work in humid or cold weather
- Handling of foods or substances in the preparation of items for consumption
- When there is a requirement for the medical examination of personnel

Clothing

Where there is a danger of contact with the moving parts of machinery, electrically energised equipment, or where the work process presents similar hazards, employees and contractors on KEFI worksites will be required to adhere to the following practices:

- Wearing clothing that fits correctly and is not loose
- Confining any hair that may be caught in the work process or equipment
- Removing or taping down dangling jewellery or similar articles that may be caught in the work process or equipment

As well as the wearing of PPE clothing that is appropriate to the hazards of the task they are carrying out, employees will wear the following:

- Fire-resistant clothing appropriate to the risk, if there may be exposure to a flash fire, molten metal, welding and burning or similar hot work hazards
- Clothing to protect skin from protracted periods in the sun
- Clothing that is appropriate to protect skin from contact with harmful substances and liquids.
- Waterproof clothing, where personnel are expected to work outside for the duration of their work activities to protect them from the wet climate, or in areas where saturation of water is expected

Eye and Face Protection

All personnel will be provided with and wear properly fitting safety eyewear, goggles, face shields, or other such protective items appropriate to the hazards in workplace conditions, such as when they

- Handle, use or are exposed to materials or substances that may injure the eyes
- Are engaged in or around work or processes where objects or particles may be thrown about or otherwise cause danger of impact with the eyes

- Are exposed to excessive light, heat rays, electric arcs or similar hazards
- Are working on, or testing energised electrical equipment
- Are working with laser beams

All face protectors and safety eyewear provided by KEFI will meet the requirements of CSA Z94.3-2002, *Eye and face protectors*.

Head Protection

All personnel will wear appropriate safety headwear where there is or may be a danger of injury to the head from falling, flying or thrown objects, or any other contacts. The safety headwear will meet the requirements of

- CSA Z94.1-2015, *Industrial protective headwear – Performance, selection, care and use.*
- ANSI Z89.1-2014, *Industrial head protection*.
- Other similar standards acceptable to the OS&H Authority of the FDRE

The safety headwear will remain in service only as long as it is in good condition and provides effective head protection.

All operators and passengers of All Terrain Vehicles as well as motorcycles on KEFI worksites will wear protective headwear that meets the requirements of

- CSA D230-M85, *Protective headgear in motor vehicle applications*.
- US Federal Standard for Motorcycle Helmets (Title-49-Transportation-Part 571.218).

An effective means of headwear retention (e.g. chin straps) will be used during any task or in conditions that may cause loss of the headwear.

Personnel involved in the preparation of food will also wear hairnets that retain hair and prevent it from contaminating food.

Hearing Protection

All personnel exposed to noise levels exceeding the permissible noise exposure limits as defined by the World Bank General EHS Guidelines: *Occupational Health and Safety, 2.3 Physical Hazards, Noise* or other applicable regulatory requirements, will be provided with appropriate hearing protection devices that will be worn in and around identified noise-intensive areas.

Respiratory Protection

Appropriate and effective respiratory protective equipment will be provided to workers where they may be exposed to concentrations of an air contaminant in excess of the applicable exposure or excursion limit, or to an oxygen-deficient atmosphere.

All respiratory protection equipment used on KEFI worksites will be selected in accordance with CSA Z94.4-2011, *Selection, use and care of respirators*.

Respirator Fit Tests and Pre-Use Inspections

Wherever a respirator requires an effective seal with the face for proper functioning, a fit test which demonstrates that the face-piece forms an effective seal with the wearer's face will be performed in accordance with appropriate standards. The fit test will be carried out as follows:

- Before initial use of a respirator
- At least once a year
- When there is a change in respirator face-piece
- When changes to the user's physical condition could affect the respirator fit.

The wearer must also be informed of any other circumstances that may affect the seal, such as growing facial hair, and that it may cause the equipment to be ineffective.

Any personal protective equipment that is to be worn at the same time as a respirator and which could interfere with the respirator fit will be worn during the fit test.

Workers will perform a positive and/or negative pressure user seal check in accordance with appropriate standards before each use of a respirator that requires an effective seal with the face for proper functioning.

17.12 MONITORING

17.12.1 Purpose

To ensure commitment to Company Policies, HSS Procedures and programmes, constant monitoring of existing procedures and working instructions is carried out through systematic evaluation. This is to ensure adherence, as well to evaluate whether procedures and working instructions are as effective as they can be, and to confirm that the necessary inspections are completed at each operational worksite in accordance with all legislative and regulatory requirements.

17.12.2 Scope

All processes, procedures and working instructions in every aspect of operations will be monitored. Priority will be given to systems which are of higher risk due to recent incidents, incident history, period since last inspections, changes in procedures, or use of new/different technology. All systems will be evaluated over a reasonable period.

17.12.2.1 HSS Programme Review and Auditing

SOPs and all associated supporting documents and appendices will be audited by the HSS Manager using the Due Diligence Checklist:

- Once per year
- Following a significant incident
- As necessary, following change of policy or procedure

Further to this, a quarterly SHE review will be performed by the H&S Superintendent and Environmental Superintendent, who will submit a report of the findings to the HSS Manager. Using the site audit checklist as a tool, the SHE Audit Report will include but will not be limited to the following performance indicators:

- Leading Indicators
- Proactive safety activities (e.g. documented hazard control measures)
- Prevention programme initiatives (e.g. education, training and safety awards)
- Lagging indicators
- Incident statistics
- Accident and injury statistics
- Disease statistics

At the discretion of the HSS Manager, external auditing of the SHE system will be undertaken a minimum of every two years to assist management in maintaining standards of excellence in safety and keeping current with industry best practices.

17.12.2.2 Construction Inspection

The Construction Manager will conduct an inspection of each construction site a minimum of once every two weeks.

Each construction site inspection conducted will be documented on the Construction Inspection Checklist Form; a copy of the completed form will be filed on site.

17.12.2.3 Operations Inspection

The General Manager will ensure that inspections of operational areas, systems and functions for each operational area on site will be carried out a minimum of once every two weeks.

Each inspection conducted will be documented on the Operational Inspection Checklist Form specific to the area and department covered; a copy of the completed form will be filed on site.

17.12.2.4 Worksite Inspection

The SHE Committee members will conduct a Safety Inspection of each worksite prior to the monthly safety meeting in accordance with established company procedure.

Each Worksite Safety Inspection conducted will be documented on the Worksite Safety Inspection Checklist Form; a copy of the completed form will be filed on site.

17.12.3 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc. that are required:

- Procedures Checklists
- Operators' Assessments
- Facilities Inspection Checklist
- Hazardous Waste Procedure Checklist

17.12.4 Quality Assessment and Control

17.12.4.1 Purpose

To ensure that all employees, contractors and community members are able to work and live in a clean environment without concern for pollution of air and water, control of excessive noise and unnecessary damage to plant and animal life.

17.12.4.2 Scope

KEFI will ensure the monitoring of air, water, and noise pollution levels in and around KEFI sites, as well as providing effective controls that will be implemented to mitigate KEFI's operational impact on the area.

17.12.4.3 Method

Water Quality Treatment and Testing

The Environmental Manager will ensure the cleanliness of local water supplies, as outlined in Section 11. They will also ensure the quality of drinking water at KEFI sites through assessment and treatment. They will also ensure the cleanliness of water containers.

Air Quality Testing and Regulation

The Environmental Officer will carry out air quality checks both on and off KEFI sites at surrounding areas, as well as access routes to and from KEFI sites often used by operational vehicles.

They will take preventative measures such as dampening roads through water dispersal to control dust levels, as well as ventilating work areas through filtration systems to contain particles.

Noise Quality Testing and Regulation

The Environmental Superintendent will carry out noise quality checks both on and off KEFI sites at surrounding areas, as well as access routes to and from KEFI sites often used by operational vehicles.

They will advise on preventative measures in noise dampening such as fencing.

Records and Reporting

Records of all qualities, testing and actions will be maintained at all times and trends will be followed and reported to ensure the effective use of controls and the fulfilment of legislative requirements and international commitments.

17.12.5 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Quality Analysis Records
- Trend Records

17.13 MEETINGS AND COMMITTEES

17.13.1 Purpose

To ensure that each worksite regularly communicates all relevant Company Policies, Procedures and Work Instructions in accordance with all applicable legislative and regulatory requirements, as well as providing effective representation through a committee of representatives for employees and employer to enable a system of assessment and a communication forum on HSS matters.

17.13.2 Scope

KEFI will ensure that SHE meetings and Security briefings are held/carried out on a regular basis, involving all Management, employees and contractors. These meetings will provide an opportunity to update personnel in the latest policies, procedures, work instructions and processes, identifying any and all amendments or additions. The minutes of every meeting, as well as the attendance list, will be recorded. Meetings will aim to provide action plans for any relevant points raised in the meetings.

KEFI will also ensure the establishment of representation through the committee system, designating committee standards as per legislative requirements, providing the election process of SHE representatives and enabling representation at the SHE Committee, and in turn the Mine H&S Committee.

17.13.3 Meetings

17.13.3.1 Toolbox Safety Meetings (Daily)

Toolbox safety meetings will be held on a daily basis throughout KEFI worksites as a communication tool to

- Alert employees to workplace hazards.
- Encourage safe work practices.
- Address safety issues as they arise on the job.
- Provide feedback.

Toolbox Representatives will conduct a five-minute Toolbox Safety Meeting in their assigned department. All Department Heads will

- Hold meetings at the beginning of shift.
- Encourage employee participation in the meetings.
- Record each meeting on the toolbox meeting log form.

17.13.3.2 H&S Meeting (minimum one per week)

The H&S Superintendent will fill out an H&S Weekly Summary Report Form prior to the weekly H&S Meeting. The H&S Summary Report will be included in the presentation/topics of discussion at the H&S Meeting.

The H&S Superintendent will conduct H&S Meetings a minimum of once per week, for all H&S Supervisors, Officers and SHE representatives on site.

Immediately following the H&S Meeting, completed copies of the H&S Weekly Summary Report will be posted at the worksite and sent to the HSS Manager.

Only the most current H&S Weekly Summary Report will remain posted at the worksite; all previous summary reports will be filed in the H&S File Folder Box.

17.13.3.3 General HSS Meeting (minimum one per month)

The HSS Superintendents will complete an HSS Monthly Summary Report Form prior to the monthly General HSS Meeting. The HSS Monthly Summary Report will be included in the presentation/topics of discussion at the General HSS Meeting.

The HSS Manager will conduct General HSS Meetings a minimum of once per month, for all HSS Managers and Supervisory personnel within the HSS Department.

Immediately following the General HSS Meeting, completed copies of the HSS Monthly Summary Report will be posted at the worksite and sent to the Managing Director.

Only the most current HSS Monthly Summary Report will remain posted at the worksite; all previous summary reports will be filed in the H&S File Folder Box.

17.13.4 Committees

17.13.4.1 SHE Committee

A SHE Committee will be established at all KEFI projects where 100 or more workers are regularly employed. The purpose of the SHE Committee is to

- Identify and correct hazards.
- Submit recommendations to KEFI for improvements to worksite safety and health.
- Provide representation for employees.
- Represent the SHE to KEFI at the Mine Health & Safety Committee meetings.

The SHE Committee will meet at least once every month in accordance with the OS&H and Environmental Laws of the FDRE.

The SHE Committee will conduct a safety inspection of the camp prior to each SHE Committee meeting. The inspection will be documented in the Operational Inspection Report with recommended remedial action to be addressed through the committee process.

The minutes of the SHE Committee meetings will be documented in the SHE Minutes Record; copies of the minutes will be sent to the H&S and Environmental Superintendents, HSS Manager and Chairman of the Mine H&S Committee immediately following the meeting.

The H&S and Environmental Superintendents will respond jointly within seven days to all SHE Committee recommendations; the written response will include corrective actions and a timeline for implementation.

17.13.4.2 Mine Health and Safety Committee

The H&S Superintendent will select three Employer Representatives to sit on the Mine H&S Committee.

Three SHE Representatives (employees that do not exercise managerial functions) shall be selected to sit on the Committee by employees on site that do not exercise managerial functions. The H&S Superintendent or his designate will post the names of the Mine H&S Committee Members immediately after the committee is formed.

The Committee meetings will be co-chaired on a rotating basis by members representing workers and members representing project management.

17.13.5 Security Briefings

The Security Superintendent will ensure that Management, employees and contractors are briefed on pertinent security concerns or ongoing issues.

They will mediate with supporting authorities where required, such as the local Police in case of a criminal investigation, and brief KEFI on all outcomes.

17.13.6 Liaison and Notifications

The HSS Superintendents and/or Community Liaison Officers (CLOs) will ensure that Community Leaders or Local Authorities are met with on a regular basis to engage on any matters that may affect any part of the HSS department's responsibilities. They will also brief, or notify them on any pertinent issues or concerns, resulting from KEFI's activities, that may adversely affect them, either directly or indirectly, whether on a short- or long-term basis.

17.13.7 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- H&S Summary Report
- Toolbox Meeting and Attendance Record
- Safety Meeting and Attendance Record
- Action Plans
- Operational Inspection Report

17.14 COMMUNICATION

17.14.1 Purpose

To ensure that adequate communication devices/systems are in place to meet the needs of operations, HSS and emergency requirements in accordance with all legislative and regulatory requirements and Company policies and procedures.

17.14.2 Scope

Communication covers any source for notification or passage of information to individuals or groups of Managers, employees, and contractors, and in some cases community members. KEFI will ensure that it covers all aspects of communication suitable to the notification requirement or passage of information, whether it is an update or emergency announcement.

17.14.3 Types of Communication

KEFI will use the following types of communication:

- Meetings, Committees and briefings (covered in Section 17.13)
- Obligatory signs
- Notices
- Media announcements
- Email
- Stationary or mobile telephone systems
- Radio communications
- Alarm and horn systems, etc.

17.14.4 Responsibility

17.14.4.1 Managing Director

Allocate sufficient staff and resources to ensure that effective communication systems are in place at the worksite; ensuring the installation, operation and maintenance of all site communication systems.

17.14.4.2 Operational and HSS Manager

Ensure that effective systems of communication are in place to support growing project activities.

Oversee compliance with good working practices for all geological activities on and off site.

17.14.4.3 Construction Manager

Maintain efficient communications, ensuring coordination of all construction projects throughout the licence area, preserving the standards set within good working practices.

17.14.4.4 Department Heads

Ensure that the personnel under their direction are compliant in the daily application of good working practices.

17.14.4.5 Workers

Comply with good working practices.

17.14.4.6 Contractors

Allocate sufficient staff and resources to ensure

- Effective communication systems are available and used by their crew
- Communications systems are compatible with KEFI processes, as required
- Compliance with good working practices within their department

17.14.5 Emergency Communication Systems

The HSS Manager will ensure that emergency communication systems are installed; emergency communications may include one or more of the following systems:

- Stationary or mobile telephone systems

- High frequency (HF) radio base station
- Very high frequency (VHF) radio network
- Alarm systems

In addition, the emergency communication system will be designed and maintained in a manner that enables effective communication between the base camp and the following locations:

- The city of Addis Ababa
- All workers in the licence area
- All construction workers outside the licence area
- Personnel in transit
- Surrounding proximal exploration sites

The HSS Manager will ensure the announcement of detailed instructions for the use of site-specific communication systems. These instructions will include but not be limited to the following:

- VHF channel, frequency and range
- Emergency codes for Security, Fire and Medical (e.g. "Medic, Medic, Medic")
- The various types of alarms for different scenarios (Explosion, Fire, etc.)

The department heads will ensure the following:

- Maintenance and issue of communication equipment.
- Correct use of communication equipment, such as call signs and emergency codes.
- That any and all contact numbers are maintained, and visible around hazardous areas.

17.14.6 Daily On-Site Communication

The HSS Manager will ensure that radio checks are performed on a daily basis to account for all personnel working in the field. Radio checks will be documented on the sign in/sign out board in the Central Monitoring Station (CMS).

Additionally, the General Manager will ensure that personnel working alone or in isolation have access to an alternate method of communication in the event that the primary system may malfunction.

17.14.7 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Equipment Maintenance Record

- Training Records
- ERPs
- Radio Net Diagram

17.15 SITE ORIENTATIONS

Site orientations will be used as a tool to help all personnel on site, or visiting the site to gain a timely understanding of the HSS and emergency-related issues at the worksite.

The H&S Superintendent, supported by the Environmental and Security Superintendents, will ensure that orientations specific to the worksite will be designed and delivered in a manner that clearly communicates to new employees, contractors, and visitors, all the relevant safety and emergency information including but not limited to the following:

- Emergency plans
- Contact numbers
- Escape routes
- Meeting areas and muster stations
- Safety/fire equipment
- Communications system
- Health & Safety practices – such as the wearing of PPE
- Environmental awareness – such as the effect of littering – carried out in support of H&S by the Environmental representative
- Security awareness – such as identification of restricted areas - carried out in support of H&S by the Security representative
- Cultural awareness – activities or habits that may be misconstrued or offensive to the local culture even if common practice in other cultures

A Safety Supervisor will conduct a site orientation for every person on site prior to the start of their required duties and within 24 hours of their arrival; each orientation will be documented on the Record of Orientation Form.

Site Orientations will be repeated on a yearly basis for employees that have returned to the worksite to keep staff abreast of any changes related to safety at the worksite.

Site Orientations will be filed on site in personnel files.

17.16 EMERGENCY RESPONSE PLANS (ERPs)

17.16.1 Purpose

To ensure that all operating locations have the necessary equipment, communication devices, personnel with the necessary skill and training for the prevention and mitigation of any emergency situations in accordance with all legislative and regulatory requirements, as well as Company procedures.

17.16.2 Scope

KEFI will ensure that appropriate personnel are identified, trained and tasked to manage, control and respond correctly; carrying out any actions required to deal with an emergency situation.

17.16.3 Types of Emergency

KEFI will have procedures and contingency plans for emergencies such as

- Medical and Medical evacuation (outbreak of disease, etc.)
- Fire
- Environmental (contamination of water supply, air pollution (chemical release), etc.)
- Dam failure
- General evacuation (civil unrest, etc.)

17.16.4 Dissemination of Information

Where an emergency situation is identified, whether actual or potential, the immediate dissemination of information to affected parties is paramount.

Those who will be directly affected and may be subject to the most severe harm should be informed immediately. As outlined in Section 17.10), this can be done in several ways but should be quick, appropriate, reliable, easily understood and received by as many affected personnel as possible.

Persons to be informed are not limited to KEFI personnel only; consideration should be given to surrounding communities and the possible effects on them, whether in the short or long term. They should be notified without delay with appropriate information to enable them to decide their immediate actions.

17.16.5 Responsibility

17.16.5.1 Managing Director

Ensure that site management has access to the resources and support required to effectively respond to an emergency at any site where operations are taking place or construction is being carried out; notifying senior management of serious emergencies as required.

17.16.5.2 HSS Managers

HSS managers and ES Managers supervise and direct the response to the emergency; relaying information to the Managing Director as specified in the ERP.

Ensure the notification of all affected personnel subject to any actual or potential harm without delay, including community members where relevant.

Provide supporting equipment and logistics in the case of assistance to local communities where the emergency warrants a response such as immediate mass evacuation.

Ensure the design, compilation, establishment, implementation and maintenance of detailed ERPs for each project.

17.16.5.3 Department Heads

Ensure that personnel assist in ERPs where required.

Close down affected operational areas and evacuate to muster areas.

Carry out a roll call of personnel at muster point.

17.16.5.4 Support Management

Provide ongoing logistical support to Emergency Response Team (ERT) as specified in the ERP.

17.16.5.5 HSS Superintendents

Activate all appropriate emergency communications devices such as alarms and radios communications, as well as initiating emergency plans and responses to tackle the emergency.

Notify all affected personnel of any actual or potential harm without delay, including community members where relevant.

Control supporting personnel, equipment and logistics in the case of assistance to local communities where the emergency warrants a response such as immediate mass evacuation.

17.16.5.6 Paramedic

Supervise and direct the medical response to the emergency including hands-on treatment for injured parties as specified in the ERP.

17.16.5.7 Contractors

Ensure that effective emergency response procedures are in place for their department to work in conjunction with the KEFI ERP for the worksite; ensuring that personnel assist in ERPs where required.

Close down of operations and evacuate to muster areas.

17.16.6 Method

17.16.6.1 General

All employees working at an operating location will receive adequate and appropriate site orientation (see Section 17.15).

All fuel/power shut-offs, emergency exits, muster areas and emergency equipment will be clearly marked and kept free of obstructions at all times.

17.16.6.2 Emergency Personnel

The HSS departments will be responsible for all emergencies at KEFI Sites. They will also be responsible for overseeing Fire response activities using allocated and trained Security personnel for assistance.

The H&S manager, together with the paramedic, will be responsible for all medical issues. Additional support will be mustered when dealing with medical incidents through nominated First Aiders.

The ES Manager and Environmental Coordinator will oversee any and all environmental emergencies using allocated and trained Security personnel for assistance.

The Security Superintendent will oversee all general emergency evacuation requirements as well as the access and egress of further emergency support services. Additionally, they will support the H&S and ES departments in dealing with large fire or chemical spillage/release scenarios.

17.16.6.3 Specific Emergency Planning

A detailed ERP(s) specific to the needs of each project, will be completed, posted and maintained by the HSS Manager and will cover topics including but not limited to

- Muster station
- Access/egress

- Communication devices including contact numbers
- Adequate transportation
- Designated responsibilities
- Equipment shutdown (if applicable)

17.16.6.4 Emergency Equipment

Required emergency equipment will be kept readily available for all operating locations and will include but not be limited to

- Detection Systems
- Alarm methods
- Fire extinguishers
- Fire blankets
- Relevant PPE
- Breathing apparatus
- Communication device(s)
- Necessary transportation

Emergency equipment will be maintained as per the manufacturer's instructions. They will be tested on a regular basis by the HSS departments and all required recompression, charging of batteries, fuelling etc., will also be ensured by the relevant departments holding the equipment and overseen by the HSS department.

17.16.6.5 Transportation

The KEFI worksite will have a dedicated Fire response vehicle, which will be fuelled and maintained at all times, ready 24/7 for reaction to any emergency incident.

The KEFI worksite will also have a dedicated ambulance, which will be fuelled and maintained at all times, ready 24/7 for reaction to any emergency incident.

Each worksite will develop and maintain a site-specific procedure detailing how an injured worker will be transported to medical aid for both urgent and non-urgent situations in the case where the ambulance is otherwise tasked.

The Paramedic will be responsible for arranging transport, by Ambulance, of the injured worker to a medical treatment facility, if he is unable to treat the worker on site; a Nurse will travel with the injured worker.

Injured workers will not, under any circumstance, drive/transport themselves to Medical Aid.

17.16.6.6 Medical Facilities and Equipment

Medical on-site facilities and equipment will be set up/selected in accordance with applicable regulations.

Medical equipment, supplies and facilities will be kept clean, dry, ready for use, and readily accessible at all times while work-related activities are being conducted at the workplace.

All equipment will be inspected and inventoried on a regular basis.

17.16.6.7 Paramedic

Whenever the Paramedic is made aware that a worker or workers have been injured, the Paramedic will

- Be responsible and have full authority for all medical treatment of an injured worker until responsibility for treatment is accepted at the medical facility of referral.
- Ensure that each new/transferred worker on site has been presented with and completed a Medical History Form, which will be kept in the confidential medical records file on site for use in the event of a medical emergency.
- Not have the authority to overrule a worker's decision to seek/refuse medical treatment or the worker's choice of medical treatment facility. Whenever an injured worker refuses the recommended treatment, the Paramedic will document the refusal on the Refusal of Medical Treatment Form, which will be filed in confidential medical records on site.

17.16.6.8 Reporting/Recording

All emergency responses and medical treatment on KEFI worksites will be recorded. Medical records must be filed with the confidential medical records on site; these records must be maintained for the minimum reporting period as required by governing regulations of the FDRE (20 years).

In addition, the Paramedic will record all injury statistics in the Monthly Injury Summary Report and provide this report to the HSS Manager at the end of each month.

The Paramedic will notify the H&S Superintendent of all injuries requiring Medical Aid as soon as is practicable; the notification will include the following information:

- Date and Time
- Patient’s name
- Type of injury
- How injury was sustained

- Treatment given at site
- Name and location of the admitting medical facility
- If non-medical accommodation will be required for the patient

The Paramedic will complete a Medical Referral Form to accompany each patient being sent off site for Medical Aid; a copy of the Medical Referral Form will be kept in the confidential medical records file on site.

The H&S Superintendent will notify the HSS Manager and Managing Director immediately of all referrals to Medical Aid.

The H&S Superintendent will ensure completion of an Accident Investigation for all work-related injuries requiring Medical Aid.

17.16.6.9 Site-Specific Procedures

The HSS departments will develop and maintain at each worksite site-specific procedures detailing the immediate measures to be taken on identifying a fire, and how and when it should be tackled. It will also develop procedures detailing the immediate measures to be taken on identifying a chemical spillage or vapour release, and how and when it should be tackled.

Each worksite will develop and maintain site-specific procedures detailing the administrative measures necessary for medical referral and admission to regional public and/or private medical facilities.

17.16.7 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Medical Assessment Form
- Medical Record
- Monthly Injury Summary Report
- Medical Referral Form
- Refusal of Medical Treatment Form
- Training Records

17.17 CRISIS MANAGEMENT TEAM (CMT)

17.17.1 Purpose

The Crisis Management Team (CMT) is formed to assess and control incidents involving KEFI sites and the surrounding areas during large or protracted emergency situations. The continued evaluation will indicate any subsequent actions required to control, limit or eliminate the concern. The CMT will manage the situation throughout and should the situation be protracted then it will be the responsibility of the CMT to ensure 24-hour cover until completion of any response actions.

17.17.2 Scope

The CMT will convene where any incident impact immediately affects KEFI's ability to carry out its normal business, or where there are serious concerns that its operations will affect the local environment. The incident may be direct or indirect, affect a more general area and not specifically the business, such as the country of operations, and may have the same effect on KEFI's ability to carry out its business.

Such concerns include but are not limited to the following:

- Mass casualty incident – accidental, negligent or deliberate.
- Kidnapping – for ransom or political reasons.
- Large-scale chemical spillage.
- Contagious disease – personnel or animals.
- Strike – by local community, employees or institutions.
- Riot – by group of employees, local community (possible pre-cursor for civil unrest).
- Flooding – natural or otherwise.
- Explosion – accidental, negligent, or deliberate, including bombs.
- Civil unrest – large disturbance in several areas including fire, assault, riot, looting and death.
- War – Civil or international.

17.17.3 Activation of the CMT

Where a serious incident has occurred or an imminent threat of a situation is expected, the response of the CMT should be to convene. This should be on a 'face-to-face basis' in an allocated Crisis Management Centre (CMC) or if this is not possible, by other communications which can be maintained constantly for the duration of the incident.

17.17.4 Dissemination of Information

The CMT must ensure that ALL actual or potentially affected persons have been notified of any incident that may directly affect their welfare, especially if it will affect their health. Consideration should also be given to notifying persons where there could be a financial impact on them.

The group should evaluate these factors when assessing the situation and must ensure that the appropriate groups are informed:

- KEFI Staff
- Contractors
- KEFI Management
- Company Directors
- Stakeholders
- Authorities, local and international, where applicable
- The Community

17.17.5 Roles and Responsibilities

17.17.5.1 Managing Director (Chairman of the CMT)

Establishment and leadership of the CMT.

Overall responsibility of any CMT procedures.

Activator of the CMT group.

Chairman and chief decision-maker in all responses.

Controller of all information such as Company Senior Management and/or board member updates.

17.17.5.2 General Manager

Establishment and leadership of the CMT in the absence of the Managing Director, and all other associated duties.

Member and technical advisor to the CMT and key decision-maker.

17.17.5.3 HSS Managers

Member and technical advisor to the CMT and key decision-maker.

Holder and maintainer of emergency response procedures and CMT procedures.

17.17.6 Process

Once the CMT has assessed the situation affecting the Company and its operations, the 'key decision voters' with the overall casting vote of the Chairman, will decide the response process to be activated.

17.17.7 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- CMT incident log
- CMT Procedures
- ERPs
- Risk Calculation Matrix

17.18 TEST AND EVALUATION

17.18.1 Purpose

To test and evaluate HSS Procedures and programmes, measuring their effectiveness and suitability; providing valuable training, team cohesion and confidence for those involved and the Company.

17.18.2 Scope

KEFI will ensure that all processes and working instructions relevant to emergency procedures are tested to ensure effective responses and controls. An evaluation will be made during each test to measure the ability of the personnel involved, particularly those responsible for the management of and reaction to emergencies, measuring their effectiveness as well as the suitability of the procedure response or control.

17.18.3 Method

The HSS departments will develop regular structured exercise plans to train personnel to deal with emergency scenarios in such a way that operations can continue with the least amount of disruption, and to test the following:

- Identification of an emergency
- Response time
- Response type
- Use of equipment
- Procedural process

- Logging
- Final outcome

The CMT, as well as other HSS Department Managers and other experts, including consultants, will initiate the exercise and conduct evaluations throughout the exercise, to measure such points as

- Individual abilities
- Type of equipment used
- Interdepartmental assistance
- Use of communications
- Process steps and their effectiveness
- Understanding of the logging process
- Whether the desired outcome is achieved

17.18.4 Evaluation

Post-exercise reports will be compiled identifying recommended actions, such as training, use of different equipment or change in procedural steps to enhance the effectiveness of the procedure.

17.18.5 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Activity Log
- Exercise Summary Report
- Procedure Evaluation

17.19 INCIDENT AND ACCIDENT INVESTIGATION

17.19.1 Purpose

To prevent and mitigate the occurrence and consequence of potentially harmful incidents and accidents at all operating locations in accordance with all legislative and applicable regulatory requirements.

17.19.2 Scope

KEFI will ensure the reporting and investigation of accidents and incidents, providing reactive solutions and preventative measures.

17.19.3 Responsibility

17.19.3.1 HSS Managers

Ensure that effective systems are in place for the prevention and mitigation of incidents, including but not be limited to the following:

- Inspection
- Reporting
- Treatment
- Investigation
- Mitigation
- Communication

17.19.3.2 HSS Superintendents

Ensure that all accident, injuries, incidents, process loss and property damage events are adequately reported and investigated; ensuring that adequate resources are assigned and effective processes are developed that result in effective investigation and reporting.

17.19.3.3 Department Heads

Ensure assistance and compliance with investigations.

17.19.3.4 Workers and Contractors

Ensure the immediate reporting, assistance and compliance with investigations.

17.19.4 Method

The HSS Manager with the assistance of the relevant department heads will undertake an investigation into the cause of any accident or other incident on KEFI worksites that

- Involved a major structural failure or collapse of a building, bridge, hoist, temporary construction support system or excavation
- Involved the major release of a hazardous substance
- Resulted in serious injury
- Resulted in injury to a worker requiring medical treatment

The HSS Superintendents will enter all serious accidents and incident into the site Incident Register Form in accordance with legislative requirements and immediately notify the Managing Director.

All personnel on KEFI worksites will

- Immediately report any Accident, Incident or Near-Miss Incident to their supervisor or SHE representative, as well as any member of the HSS Department.
- In cases where injuries occur, immediately report to the Paramedic on duty at the medical facility.
- Report an injury, regardless of how small, that occurs during the course of employment.

The HSS Superintendents will ensure that all reported incidents/accidents are immediately communicated to all the crew who may be affected by the occurrence; the incident will be included as a topic for discussion at the next general HSS meeting.

17.19.4.1 Near-Miss Incidents

Incidents where no person was injured but the potential for serious injury was present, are considered 'Near-Miss' Incidents, and must be reported and investigated immediately.

The H&S Superintendent will conduct an investigation and complete a Near-Miss Investigation Form immediately upon receiving notice of a Near-Miss Incident.

17.19.4.2 Accidents

Whenever an injury resulting from a work-related accident occurs, and Medical Aid is required, the H&S will notify the HSS Manager and complete an Accident Investigation form.

17.19.4.3 Criminal Incident

Whenever a criminal act takes place, such as theft, criminal damage, arson and assault, the Security Superintendent shall be notified. If the incident(s) is of a serious nature and/or the complainant wishes to make a formal complaint, they will inform the Police for further investigation and possible prosecution. In such cases, the Security Superintendent will liaise with the Police at all times, assisting them in the collation of any evidence for prosecution

17.19.5 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Incident Register Form
- Incident Investigation Form
- Near-Miss Incident Investigation Form
- Incident Investigation
- Training Records

17.20 STORAGE AND DISTRIBUTION

17.20.1 Purpose

To ensure that appropriate measures are in place to effectively control the issue and return of items to the appropriate end users as well as the correct storage of items appropriate to the manufacturer's recommendations, legislative requirements, and HSS concerns.

17.20.2 Scope

KEFI will ensure that items will only be issued by and to personnel authorised to handle or use the equipment. Where appropriate, checks will be made prior to distribution to ensure that they are suitably qualified to use the items and are aware of all safety requirements associated with such items. Records and controls will be maintained for the issue and return, as well as for checking and recording the serviceability/damage of such equipment prior to issue and on return.

KEFI will identify the correct methods of storage for hazardous materials, contaminated waste, degradable products such as food and explosives, and all other items requiring full or periodic storage to ensure that all personnel are safe, secure and healthy and that the environment is also protected.

17.20.3 Responsibility

Support departments such as Camp Management, the Maintenance Department, the HSS Department and any other departments that are required to store any item will ensure that they follow the procedures laid out for the storage of allocated items.

17.20.4 Method

Storage items must always be stored as per KEFI procedures, legislative requirements, and as per the manufacturer's recommendations. When stacked, they must be placed in a safe manner so as not to topple or fall. The base should be strong enough to stack other items on top of it. The stack should not be so high that it crushes the base or that the top cannot safely be accessed.

17.20.4.1 Hazardous (Chemical) Materials

Hazardous materials will be separated and stored in the correct containers (that will not degrade due to the hazardous substance), at the correct temperature, along with any required ventilation, in areas of suitable size as per any legislative requirements or manufacturer's recommendations. They will be labelled to show the type of hazard, quantity and the date of expiration, where applicable. Further restrictions, such as separating cages or separate storage buildings will be utilised as required, along with obligatory warning signs. Emergency equipment suitable to deal with the hazard must be sited within a reasonable distance from the materials to ensure that an emergency, such as fire or leakage, can be dealt with immediately and appropriately, without persons having to enter a hazardous situation to appropriate the emergency equipment.

17.20.4.2 Hazardous Waste

Hazardous waste will be separated and stored in the correct containers (that will not degrade due to the hazardous waste) and at the correct temperature in areas of suitable size as per any legislative requirements or manufacturer's recommendations. They will be labelled to show the type of hazardous waste and quantity. Further restrictions, such as separating cages or separate storage buildings will be utilised as required, along with obligatory warning signs. Emergency equipment suitable to deal with the hazardous waste must be sited within a reasonable distance from the materials to ensure that an emergency such as fire or leakage can be dealt with immediately and appropriately without persons having to enter a hazardous situation to appropriate the emergency equipment.

17.20.4.3 Explosives

Explosives will be stored separately in the correct containers (that will not degrade due to the explosives) and at the correct temperature in areas of suitable size as per any legislative requirements or manufacturer's recommendations. They will be labelled to show the type of explosive, quantity and expiration dates. Further restrictions such as separating explosives from detonators will be instigated. Storage areas and inner cages will be identified with appropriate obligatory warning signs. Emergency equipment suitable to deal with incidents involving explosives must be sited within a reasonable distance to ensure that an emergency such as fire or explosion can be dealt with immediately and appropriately without persons having to enter a hazardous situation to appropriate the emergency equipment.

17.20.4.4 Food

Food materials will be separated and stored in the correct containers (that will not degrade, or contaminate its contents) and at the correct temperature. They will be labelled to show the type of food, quantity and date of expiration.

17.20.4.5 PPE

The issue of PPE to personnel requires that the employee or contractor be responsible for the equipment at all times. They must store it appropriately and securely so that it remains in the best condition possible and is maintained effectively. Where possible, KEFI will provide storage areas for such items and may also provide cleaning materials to maintain the issued equipment.

17.20.5 Access Control

KEFI will ensure the control of access to sensitive and hazardous materials, safeguarding such materials from access by unauthorised personnel.

17.20.6 Disposal

KEFI will ensure the correct collection, storage and disposal of hazardous or contaminated waste, as well as normal and food waste, as follows:

- Food waste – through composting.
- Sewage – through treatment and filtration.
- Normal waste – by burning and burial.
- Hazardous/contaminated waste – collection by legal service providers and disposal under the legislative requirements of the FDRE. Service providers will be monitored and tested, ensuring appropriate and legal services, etc.

17.20.7 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Data sheets for each product
- Stores Audit
- Stock review
- ERPs – in regard to hazardous materials, fire, etc.
- Disposal procedures and checks

17.21 HANDLING

17.21.1 Purpose

To ensure that items are effectively and correctly handled with due regard to possible hazards.

17.21.2 Scope

KEFI will ensure that appropriately trained and qualified personnel will only handle items in the appropriate manner. Procedures will ensure effective management oversight, where required, and any additional requirements in the handling process.

17.21.3 Working Practices

Through the Hazard Identification and Risk Assessments, suitable Controls will be identified to ensure safe handling during working practices. This may involve the use of PPE, automated equipment, training in correct lifting methods, or hygiene in the handling of food such as

- Awareness of change in food type being prepared
- Awareness of contamination from the process of sneezing or coughing, etc.

17.21.4 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- H&S Summary Report
- Kitchen Inspection Checklist
- Training Records
- Medical Incident Records

17.22 EARTHWORKS AND EXCAVATION

17.22.1 Purpose

To ensure that all excavation activities are conducted in accordance with all applicable legislative and regulatory requirements and in a manner that does not expose personnel to undue risk.

17.22.2 Scope

KEFI will ensure that all processes and procedures are in effect and adhered to in regard to any excavation activities, to ensure the safety and health of personnel as well as the welfare of the environment, ensuring the minimum impact whilst works are carried out.

17.22.3 Responsibility

17.22.3.1 Managing Director

Ensure the establishment, implementation and maintenance of relevant procedures, promoting compliance and good working practices for all earth-moving activities for KEFI.

17.22.3.2 HSS Manager

Ensure the inspection prior to, during and after excavation, ensuring minimum effects on the environment as well as safe working practices.

17.22.3.3 General Manager

Ensure compliance with good working practices for all earth-moving activities for KEFI.

17.22.3.4 Construction Manager

Ensure the compliance with good working practices for all earth-moving activities for KEFI; advising the HSS Manager on issues or plans related to earth-moving activities; ensuring that all staff participating in below-surface activities are thoroughly trained, utilising correct PPE, and that effective safety measures are adhered to.

17.22.3.5 Operators

Ensure that they are compliant with all aspects of operating mobile equipment and that they are aware of equipment limitations on rough and sloping ground. Ensure that safety clearance areas are marked and the relevant personnel are notified prior to operation and that warning devices are operational during the works.

17.22.3.6 Workers

Comply with good working practices; immediately informing the H&S Manager of any observed unsafe act or condition regarding vehicles and heavy equipment on site.

17.22.3.7 Contractors

Comply with good working practices; ensuring that all staff participating in earth-moving activities are thoroughly trained in the application of good working practices; advising on issues or plans related to earth-moving activities.

17.22.4 Method

17.22.4.1 Preparation

Prior to commencement of any trenching or excavating project, the Construction Manager or Operational Management will notify the HSS Manager to discuss work procedures including but not limited to the following:

- Location of and access to works

- Size of works
- Identified hazards and risk assessments
- Period of operation
- Any trees, utility poles, rocks and other objects near the area to be excavated that must be removed or secured before excavation is started.
- Any compensation required for site access and any construction required as part of the access.

17.22.4.2 Testing (Visual and Physical)

The evaluator (on-site engineer) will observe and test the entire excavation, including the material adjacent to the site and the material being excavated, for the following:

- Signs of vibration, tension cracks and crack-line openings along the failure zone
- Signs that the material has been previously disturbed and if backfill was used
- Signs of bulging, boiling and sloughing
- Indications of layered geologic structuring
- Signs of surface water seeping from the sides or bottom of the excavation

In addition, the evaluator will check the area adjacent to the excavation for signs of surcharging, foundations, or other intrusions into the failure zone.

17.22.4.3 Operations

As per operational procedures and OH&S FDRE regulations, the depth and size of any excavation should be planned with benching (stepping) levels, or sloped appropriately so as to help prevent collapse and to mitigate safety concerns for personnel operating in any trenches/voids.

Procedures must specify depths and ratios of benching and slopes, as well as entrances and exits, equipment to be used, and actions to be taken in a collapse, and will detail further aspects such as

- Voids must be of such a size that operating personnel are able to work without hindrance and have the ability to move around and turn within them.
- Personnel working in any voids must wear appropriate PPE, and work in groups of no fewer than two.
- All excavation sites must be marked and barricaded in order that no personnel or animals can wander in and fall into any voids. Voids must also be barricaded and marked in order that workers do not accidentally fall in.
- All excavated material will be kept at least 1 m from the edge of a trench and be placed in such a way that it channels run-off water away from the excavation.

- Access water is to be monitored and no work is to be carried where water levels are excessive and regarded as a risk.

17.22.4.4 Lighting

There should be sufficient lighting around the excavation area, particularly at access points.

17.22.4.5 Backfilling Trenches

Trenches on KEFI worksites will be backfilled as soon as is practical after the work is completed.

Prior to backfilling, the Environmental Superintendent will evaluate and record the standard of the site and assess any possible contamination concerns.

17.22.5 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Worksite checklist
- Environmental Risk Assessment
- H&S Risk Assessment
- Operational Procedures
- Rescue Emergency Plans

17.23 CONSTRUCTION

17.23.1 Purpose

To ensure that the appropriate measures for worker safety are incorporated into all planning and construction of structures at KEFI worksites in accordance with the World Bank General (EHS) Guidelines: *Occupational Health and Safety, 2.1 General Facility Design and Operation,* including all applicable legislative and regulatory requirements.

17.23.2 Scope

KEFI will ensure that all personnel working on KEFI sites during the construction phase adhere to standards set by KEFI and the legal requirements of the FDRE. All contractors will be contractually obliged to fulfil all specified HSS requirements and show commitment to SHE practices.

17.23.3 Responsibility

17.23.3.1 Managing Director

Ensure the legal structure to obligate contractors to maintain KEFI standards and to make sure management has the resources to support high standards of safety in planning and construction of site structures.

17.23.3.2 HSS Manager

Ensure that all personnel at KEFI sites adhere to and maintain high standards of SHE in planning and construction of site structures.

17.23.3.3 Construction Manager

Oversee all plans, designs and construction for proposed site structures, to ensure compliance with good working practices.

17.23.4 Method

17.23.4.1 Planning, Design and Construction

The Construction Manager will oversee all plans and designs for proposed site structures such as

- Plant area
- Camp accommodation
- Catering facilities
- Medical facility
- Water tailing facilities
- Access roads

All designs will meet the relevant safety and FDRE fire code standards and will be assessed by the H&S Superintendent.

Any earth-moving, heavy equipment operations, working at heights, working close to severe declines or other hazardous activity will perform in accordance with the operating procedures mentioned in this section.

Designs will factor in permitting processes, prior to construction.

17.23.4.2 Access and Egress

All KEFI site structures will have safe access for personnel including stairs and handrails, where necessary.

All KEFI site structures will have adequate and clearly marked egress, to ensure that personnel are able to exit the structure in a safe and orderly fashion in the event of an emergency.

The Security Superintendent will ensure that no unauthorised personnel will enter the construction area.

17.23.4.3 Lighting and Air Quality

The Construction Manager will ensure that all facilities on the site have adequate lighting to support safe work processes within. He will also ensure that all facilities have adequate ventilation to manage the air quality, depending on work activities and the level of particulates in the workspace.

It must be noted that if air quality cannot be managed through ventilation, the hazard level of the work activity must be assessed and control measures put in place prior to the commencement of work.

17.23.4.4 Health and Hygiene

The Support Management will ensure adequate hand washing, showers and restroom facilities to accommodate the number of personnel on site at any time.

Showering and restroom facilities for women must be separate from those for men in accordance with applicable legislative and regulatory requirements.

Laundry facilities will be provided by Support Management to enable personnel to wash and dry their duty clothes.

17.23.5 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Activity Log
- Risk Assessments

17.24 MOBILE EQUIPMENT

17.24.1 Purpose

To ensure that all Mobile Equipment is operated, inspected, repaired, and maintained in a safe manner in accordance with all legislative and regulatory requirements, as well as the manufacturer's requirements.

17.24.2 Scope

KEFI will ensure that adequate measures are in place to support the safe transport of personnel, goods and equipment, to, from and at KEFI worksites. The operation of all equipment will be in accordance with the designated purpose of that vehicle. Operators, both prior to use and after use, will carry out inspections of vehicles and equipment on a daily basis. Mechanics will carry out scheduled maintenance and service checks, and will repair identified issues or failures. Modification of vehicles will only be carried out in accordance with all legislative and regulatory requirements.

17.24.3 Responsibility

17.24.3.1 Human Resources Manager

Ensure that only qualified drivers with current licences are employed on KEFI worksites.

Ensure that all insurance documentation is kept updated and available.

17.24.3.2 Managing Director

Ensure that effective transportation management systems are being implemented to support the safe transportation of personnel at KEFI worksites. Ensure the quarterly auditing of hired vehicle and charter aircraft service providers to ensure compliance with applicable legislative and regulatory requirements of the FDRE and KEFI safety standards.

17.24.3.3 HSS Manager

Ensure that safe and secure transportation management systems are being implemented to support the transportation of personnel to, from and at KEFI worksites. Carry out Monthly random checks of vehicles, and operator's licence and qualifications, and driver assessments, where required. In the case of charter aircraft,

- Ensure the posting of speed and traffic restriction notices and the compliance with such notices.
- Ensure that service providers fulfil their contractual obligations.

- Ensure compliance with legislative and regulatory requirements of the FDRE.
- Ensure the maintenance and repair of landing sites.
- Provide assistance with landing procedures, area checks and clearance, as well as landing guidance.
- Arrange for qualified inspectors to carry out random checks of the service provider.

17.24.3.4 General Manager

Ensure that all vehicles and equipment used are registered, roadworthy, and comprehensively insured.

17.24.3.5 Construction Manager

Ensure that no KEFI employee operates or permits a worker to operate any vehicle which is, or could create, an undue hazard to the health and safety of any person aboard. Conduct documented training for drivers using the defensive driver syllabus; ensuring compliance with good working practices.

17.24.3.6 Support Management

Ensure the maintenance of Mobile equipment on a regular basis.

Ensure the provision of fuel, lubricants and other such items for the daily use of mobile equipment.

17.24.3.7 Operators

Complete job safety analyses for the work activities of their department; ensuring that the control measures put in place to decrease the risk are maintained at all times; daily documented inspection of their equipment; complying with good working practices.

17.24.3.8 Contractors

Ensure that only qualified operators are tasked with Mobile and Heavy Equipment Operations at the worksite; overseeing all operations to confirm safe work practices and compliance with good working practices.

17.24.4 Maintenance

All design, fabrication, use, inspection and maintenance of mobile equipment on KEFI worksites will comply with the requirements of the following applicable standards:

- Articulating Boom Cranes: ANSI/ASME B30.22-2010

• Four Wheel All-Terrain Vehicles:	ANSI/ASME SVIA 1-2010
• Mobile and Locomotive Cranes:	CAN/CSA Z150-2011 or ANSI/ASME B30.5-2014
• Powered Industrial Trucks (low lift and high lift):	ANSI/ASME B56.1-2009
• Rough Terrain Forklifts:	ANSI/ASME B56.6-2011
• Side Boom Tractors:	ANSI/ASME B30.14-2010
• Vehicles with Mounted Aerial Devices:	CAN/CSA C225-2010
• Safety and Hazard Warning:	ISO 9244:2008
• Lift Truck Operator Training:	CSA B335-2015

17.24.5 Operation of Vehicles and Equipment

Personnel operating vehicles and equipment will be licensed and adequately trained to operate the vehicle and equipment. They must be aware of the following:

- Dimension of the vehicle – height, length, width, weight, etc.
- Capabilities of the vehicle – speed, stopping distance, load capacity, weight-lifting ability, incline/gradient limits, etc.
- The correct way to load the vehicle in accordance with legislative requirements for travel on a public highway and with the load safely secured to avoid further injury in case of an accident.
- How to operate the vehicle – starting, stopping, safety checks, identification of mechanical issues, etc.
- How to maintain the vehicle – daily inspections, light operations, fluid checks and replacement, tyre pressure, fuelling, etc.
- Equipment checks – warning triangle, tyre changing tools, jacks, etc.
- Safety concerns – operating clearance area, blind spots, use of assistance in guiding, as well as warning devices such as horns, amber flashing lights, etc.
- Reporting of defective equipment and identification of non-compliance with procedures, such as near misses, etc.
- Defensive driving techniques in off road terrain and severe climate.
- Traffic accident and breakdown procedures.
- FDRE traffic laws.

17.24.6 Use of Heavy Equipment

Prior to commencing equipment operation, Heavy Equipment operators will place relevant safety warning signs at least 100 m before the working area of operations. Heavy Equipment operators on KEFI worksites will

- Use handles/footrests when mounting or dismounting equipment.
- Maintain VHF communication with base camp for emergency response.
- Wear seatbelts at all times while driving equipment.

- Wear appropriate PPE when operating equipment.
- Wear high visibility vests during operations.
- Establish a 20 m radius safety fence around any drill site.
- Operate any warning devices such as flashing lights, use of the horn, where required.

All personnel will keep a minimum distance of 20 m from operating equipment unless permission has been given by the operator to come within this radius after they have stopped the machine (blade or bucket on ground); in addition, personnel working near or around equipment will wear a high visibility vest in accordance with established company policy/procedure as well as any other PPE required.

17.24.7 All-Terrain Vehicles (ATVs)

All ATV operators shall use ATVs in accordance with the instructions in the operator's manual. The ATV operator's manual will be kept in a secure place readily accessible to the operator.

All ATV operators on KEFI worksites will wear safety headgear and clothing suitable for the environmental conditions.

All operators will have to be authorised by the General Manager.

17.24.8 Airplanes

The HSS Manager will identify the time, location and expected aircraft specifics prior to loading preparation, including but not limited to

- Type of plane
- Available payload
- Any specific airline requests/recommendations

The Managing Director will ensure the preparation of the flight manifest, including but not limited to

- Names of passenger(s)
- Weight of each passenger (kg); verified by two independent company sources
- Number of baggage items, including total weight (kg); verified by two independent company sources

Operational Management will communicate to departments the scheduled departure time and the remaining total space/weight available for sample transport. They will also ensure that all dangerous goods are transported safely and in accordance with applicable regulatory requirements.

The H&S Superintendent and Construction Manager will ensure all dangerous goods are transported safely and in accordance with applicable regulatory requirements.

The Supervising Geologist will ensure that any necessary samples are prepared/ready for pick-up and that the Sample Submittal Form and the Chain of Custody Form are accurately completed and sent with the samples.

All prepared cargo will be picked up/loaded, the flight departure confirmed, and all cargo delivered to the flight departure point.

17.24.9 Helicopters

Prior to any scheduled helicopter landing, the HSS Manager will select, identify and communicate a designated landing area.

Designated landing areas will be

- Flat and of stable ground
- Of sufficient size to safely accommodate the type of helicopter scheduled to land
- Clearly marked so the pilot can visually identify the intended area and any hazards
- Kept clear of all debris that could become airborne, risking injury and/or damage to the helicopters rotors/turbines

During take-off and landing of the helicopter, all personnel in the proximity of the area of operation will

- Secure all gear/equipment.
- Be positioned upwind of the landing pad (near a natural protective feature if possible).
- Shield eyes while maintaining visual contact with the machine at all times.

No personnel or equipment will approach the incoming helicopter until it is safely positioned on the ground and the pilot has signalled/communicated that it is safe to approach and/or the engine switched off and all blades are stationary.

Personnel will approach the helicopter and depart the helicopter in accordance with the following:

- Stay within the pilots view.
- Stay in a crouched position.
- Never walk towards the rear of the helicopter.
- Never walk downhill towards the helicopter.
- Carry all hand tools/equipment horizontally, below waist level (never upright).

After completion of loading, the HSS Manager, or his designate, will confirm with the pilot that the helicopter is correctly loaded, and ready for take-off.

17.24.10 Escort

Vehicles will be escorted to and from KEFI sites, where applicable and required.

17.24.11 Securing

All vehicles will be secured when not in use by an effective locking mechanism provided on the vehicle to prevent access and removal of such items as fuel. Vehicles and equipment will be parked in designated areas, which will be secured by Security personnel. Vehicle parking areas will be monitored and patrolled 24/7 by Security staff.

17.24.12 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Mobile Equipment Inspection Checklist
- Maintenance Record
- Transport Log
- Vehicle Inspection Proforma
- Driver Assessment
- Defensive Driver Training Syllabus

17.25 MOTORISED EQUIPMENT

17.25.1 Purpose

To ensure that adequate measures are in place to ensure the safety and security of personnel operating or in the vicinity of motorised equipment at KEFI worksites.

The operation, inspection, repair, maintenance and modification of motorised equipment will be carried out in accordance with all legislative and regulatory requirements, as well as the manufacturer's recommendations.

17.25.2 Scope

KEFI will ensure that adequate measures are in place to support the safe use of motorised equipment at KEFI worksites. The operation of all equipment will be in accordance with the designated purpose of the equipment. Operators will carry out inspections of equipment on a daily basis, both prior to use and after use. Mechanics and electricians will carry out scheduled maintenance and service checks and will repair identified issues or failures. Modification of equipment will only be carried out in accordance with all legislative and regulatory requirements.

17.25.3 Types of Motorised Equipment

Motorised equipment involves moving parts powered by a motor, i.e. moving, rotating and vibrating equipment.

The following are examples of such equipment:

- Winches
- Conveyer belts
- Pumps
- Generators
- Feeder Breakers
- Crushers and Mills, etc.

17.25.4 Responsibility

17.25.4.1 Human Resources Manager

Ensure that only qualified operators with current licences are employed on KEFI worksites and that continual training takes place.

17.25.4.2 Managing Director

Ensure that the provision, installation and maintenance of motorised equipment, especially in the case of service of third-party providers.

Ensure quarterly auditing of service providers to ensure compliance with applicable legislative and regulatory requirements of the FDRE and KEFI safety standards in regard to their maintenance and installation engineers.

17.25.4.3 HSS Manager

Ensure good working practices for operators and safe use and working systems in and around motorised equipment at KEFI worksites. Inspect safety guards on equipment to ensure that they are being used correctly, effectively and are fully serviceable. Ensure that lockout procedures are followed and that regular inspections are carried out during the lockout process.

17.25.4.4 General Manager

Ensure that all the equipment used is serviceable and installed correctly with effective safety measures as per the manufacturer's and legislative requirements.

17.25.4.5 Construction Manager

Ensure that no KEFI employee operates or permits a worker to operate any equipment which is, or could create, an undue hazard to the health and safety of any other person. Conduct documented training for operators ensuring compliance with good working practices.

17.25.4.6 Support Management

Ensure the maintenance of mobile equipment on a regular basis.

Ensure the provision of fuel, lubricants and other such items for the daily use of mobile equipment.

17.25.4.7 Operators

Complete job safety analyses for the work activities of their department; ensuring that the control measures put in place to decrease the risk are maintained at all times; daily documented inspection of their equipment; complying with good working practices. Report any deficiencies in equipment operation.

17.25.4.8 Contractors

Ensure that only qualified operators are tasked with motorised equipment operations at the worksite; overseeing all operations to confirm safe work practices and compliance with good working practices.

17.25.5 Maintenance

Maintenance will be carried out at regular intervals by qualified personnel in accordance with the manufacturer's design, use and inspection methods, and in line with legislative requirements on the maintenance of such equipment. Lockout procedures will be followed rigorously to ensure that equipment is isolated and inoperable during maintenance; these involve but are not limited to

- Notifying the relevant departments of the imminent lockout procedure
- Shutting off the equipment
- Identifying and isolating the power source to the equipment
- Tagging and locking equipment, identifying that it is locked out for maintenance

- Testing the lockouts ensure that the equipment is off and isolated
- Utilising SHE representatives to ensure that no one attempts to reactivate the machinery
- Notifying H&S department so that they can carry out checks on the procedure
- Following the procedures for releasing the equipment from lockout

17.25.6 Operation of Equipment

Personnel operating equipment will be adequately trained and, where required, licensed to operate the equipment. They must be aware of the following:

- Capabilities of the equipment – operating speeds, load capacity, weight-lifting ability, etc.
- How to operate the equipment – starting, stopping, emergency stopping, shutting down, safety checks, identification of mechanical issues, etc.
- How to maintain the equipment – daily inspections, where required, fluid checks and replacement, pressure tests, fuelling, etc.
- Equipment checks –tools, safety guards, etc.
- Safety concerns – operating clearance area, danger spots, as well as warning devices such as alarms, amber flashing lights.
- Reporting of defective equipment and identification of non-compliance with procedures, such as near misses, etc.
- Accident procedures.

17.25.7 Monitoring

A CCTV will generally cover all operational areas that involve motorised machinery. This will enable not only the identification of breakdowns or equipment stoppage, but also provide an overview of operational employees and contractor work practices and procedures.

17.25.8 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Equipment Inspection Proforma
- Operators Assessments
- Maintenance Records
- Lockout Procedure Checklist

17.26 TRAINING

17.26.1 Purpose

To ensure all personnel at KEFI worksites receive appropriate training to maintain a safe, secure and healthy working environment in accordance with applicable legislative and regulatory requirements of the FDRE and international bodies.

17.26.2 Scope

KEFI will ensure that all its staff and contractors are suitably qualified for the task in which they are employed and trained in the duties that they must carry out. Training will ensure that personnel are capable of working effectively in their allocated roles but that they are also aware of all procedures and working instructions, which also enable them to work safely, securely and to participate in maintaining a healthy environment. All training will be recorded and evaluated.

17.26.3 Responsibilities

17.26.3.1 Human Resources (HR)

It is the role of the Human Resources department to ensure that suitably qualified candidates are recruited for positions that are available with KEFI. They will ensure, through a selective process in conjunction with the Line Manager of the position available, that the candidates are capable of performing the duties of the position, or have the ability to be trained appropriately to a sufficient standard to work effectively in the allocated position.

17.26.3.2 Managing Director

Allocate sufficient staff and resources to ensure that effective training processes are implemented as required; overseeing compliance with good working practices. Conduct documented site orientations for all personnel; providing documented on-site training for workers through safety meetings, defensive driver syllabus, job safety analysis, and other forums outlined in this section; ensuring compliance with good working practices.

17.26.3.3 Line Manager and Site Managers

Managers are responsible for ensuring that their employees are capable of carrying out their duties proficiently either by previous experience and qualifications and after an initial assessment, or by task-specific training, such as

- Job procedure, instruction and site specifics
- Practical hands-on demonstration
- Manual handing

- Job safety analysis controls

They must also ensure that they provide sufficient time and resources to carry out effective training and compliance with good working practices.

17.26.3.4 HSS Manager

Ensure that the HSS department with its various responsibilities in Health & Safety, Environment and Security provides training, education and orientation programmes that are implemented at the worksite to support growing project activities.

Allocate sufficient staff and resources to ensure that effective training processes are implemented as required; overseeing compliance with good working practices.

Provide trainers to provide documented on-site training for Managers, employees and workers through various training programmes, awareness sessions and meetings to cover such matters as

- Hazard identification and analysis
- Systems checks
- Lockout procedures
- Emergency response procedures
- Defensive driver syllabus
- Health and hygiene matters
- Crime prevention
- Job safety analysis, etc.

17.26.4 Training Needs

17.26.4.1 HSS Training

All Managers, employees and contractors will receive training enabling them to understand, carry out and comply with good working practices in their field and in general SHE practices as well as Security requirements. They will be trained in identifying and reporting hazards.

SHE representatives will receive further training in carrying out inspections of working areas and practices to ensure that they are appropriate and effective for maintaining the safety, health and environment of all staff, contractors, visitors and the local community.

17.26.4.2 Communication Training

Employees responsible for operational or emergency communication will receive documented, on and off-site training in policy, procedure, and site specifics, as well continuation training on a regular basis.

17.26.4.3 Certification and Licence Training

Employees responsible for operating mobile equipment will be holders of an applicable licence and undergo refresher training or will receive on-site training to qualify for certification or a licence, where applicable.

All KEFI employees responsible for the operation of transport vehicles will receive documented, vehicle-specific training in policy, procedure and site specifics.

17.26.4.4 Operating Skills Training

Employees responsible for operating equipment will either be previously trained and undergo refresher training, or will receive on-site training to be qualified to use specific equipment.

All KEFI employees responsible for the operation of equipment will receive documented, equipment-specific training in policy, procedure and site specifics.

17.26.4.5 Handling Training

Employees will be trained in various handling areas such as

- Posture and lifting techniques
- Food handling and cleanliness
- Correct use of PPE when dealing with hazardous substances

17.26.4.6 PPE Training

Employees will be trained in the correct use, wearing, storage and maintenance of PPE.

17.26.4.7 Emergency Training

Certain employees will be identified for additional roles and will receive documented, on-site training in relation to such requirements as

- Policy, procedure, instruction and site specifics
- Practical hands-on use and firefighting skills
- First Aid and medical treatment

17.26.5 Reference Documents

The following are only some examples of the documents needed in regard to this section and is not an exhaustive list of the forms, checklists, procedures, etc., that are required:

- Training Needs Analysis
- Training Programme
- Training Record

17.27 REQUIRED DOCUMENTATION

KEFI will maintain the minimum following records both in a cloud-based storage system and hard copies stored in a document control room:

- Health and Safety Plan
- Security Plan
- Environmental Plan
- Organisational Chart
- Employee Feedback, Comments and Suggestions
- Record of Progress towards the SHE Systems
- Training Records
- Significant Risks (aspects) as defined by the risk assessment process
- HSS Audit Findings
- Relevant specific Legislative Requirements/Licences/Permits
- Waste Disposal Forms
- Emergency Plans
- Emergency Preparedness and Response Procedures
- Fire/Emergency/Incident Response logbook
- Copy of current Employer's Liability Insurance
- Accident/Incident Reporting Book
- Accident/Incident Investigation Reports
- Material Safety Data Sheets for all chemicals
- Working Instructions
- HSS Programmes, Procedures and Protocols
- Employee accreditations, certifications, permits, licences and appointments
- Records of significant HSS impacts and aspects
- Risk Assessments
- Job Safety Analysis
- Document Control Procedure
- List of appointed personnel
- Due Diligence Checklist
- OHS Internal Auditing Report

- Camp Inspection Checklist
- Construction Inspection Checklist
- Drilling Inspection Checklist
- Worksite Inspection Checklist
- Mine Construction Operations
- Drill Records
- Minutes of SHE meetings
- Minutes of SHE Committee meetings
- Minutes of Mine Health and Safety Committee meetings

17.28 REFERENCES

ANSI F 2412, *Test methods for foot protection.*

ANSI F 2413, *Specification for performance requirements for protective footwear.*

ANSI Z89.1-2014, *Industrial head protection*.

ANSI/ASME B30.5-2014, *Mobile and locomotive cranes.*

ANSI/ASME B30.14-2010, *Side boom tractors*.

ANSI/ASME B30.22-2010, *Articulating boom cranes.*

ANSI/ASME B56.1-2009, *Low lift and high lift trucks.*

ANSI/ASME B56.6-2011, *Rough terrain forklifts*.

ANSI/ASME SVIA 1-2010, *Four wheel all-terrain vehicles*.

CSA B335-2015, *Lift trucks*.

CSA C225-2010, *Vehicle-mounted aerial devices.*

CSA D230-M85, *Protective headgear in motor vehicle applications*.

CSA Z94.1-2015, *Industrial protective headwear – performance, selection, care and use*.

CSA Z94.3-2002, *Eye and face protectors.*

CSA Z94.4-2011, *Selection, use and care of respirators.*

CSA Z150-2011, *Safety code on mobile cranes*

CSA Z195-2009, *Protective footwear*.

Health, Safety and Security (HSS) Manual and the Environmental and Social (ES) Manual, *KEFI Internal document.*

ISO 9244:2008, *Earth-moving machinery – Machine safety labels – General principles*.

SANS 1186 (all parts), *Symbolic safety signs*.

US Federal Standard for Motorcycle Helmets (Title-49-Transportation-Part 571.218).

World Bank General EHS Guidelines: *Occupational Health and Safety, 2.1 General Facility Design and Operation.*

World Bank General EHS Guidelines: *Occupational Health and Safety, 2.3 Physical Hazards, Noise.*

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KEFI MINERALS

SECTION 18 Conclusions and Recommendations

Tulu Kapi Gold Project Definitive Feasibility Study July 2015

Golder Associates

epoch resources (pty) ltd

SNOWDEN

25 YEAR JUBILEE SENET COMMITTED TO EXCELLENCE

Scoping Studies | Prefeasibility Studies | Feasibility Studies | Engineering | Procurement and Logistics | Construction Management | Commissioning

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18.1 CONCLUSIONS

KEFI in consultation with all the consultants that produced the DFS, concludes that the Tulu Kapi Gold Project is technically viable based on the detailed evaluation undertaken to definitive feasibility study standards.

SENET, in consultation with KEFI, is also of the opinion that the Tulu Kapi Gold Mine could be constructed and commissioned to be in production by the first quarter of 2017, with construction commencing in the fourth quarter of 2015, subject to successful mitigation of various adverse factors.

The Tulu Kapi Gold Project is an economically attractive mine development. Applying a flat long-term gold price of US$1,250/oz, after-tax cashflows are estimated to total US$270 million. The mine is estimated to produce 961,333 ounces over 13 years at an average cash operating cost of US$577/oz of gold produced.

The main elements of this study comprise:

- Conversion of the Mineral Resource to an Ore Reserve in accordance with the requirements of the JORC Code (2012).
- Comprehensive geotechnical, engineering and hydrological studies in order to complete a detailed mine design and optimisation.
- Metallurgical test work carried out on a range of variability samples taken from across the Resource; both lateral and vertical, enabling a recommended process route to be developed and confirmed.
- Process design and preliminary engineering suitable for cost estimation of the project to within -10 +15 % accuracy. Detailing of all labour requirements and mine and plant consumables, in order to confirm the estimated operating costs.
- A Light Detecting and Ranging (LiDAR) survey over the project affected area to provide topographic contours at 50cm spacing and colour orthographic air photos for the detailed design and engineering of all earthworks (roads, rock dumps, tailings storage facility (TSF) etc.).
- Geotechnical logging and laboratory test work on PQ drill core and pit samples specifically provided to ascertain the characteristics of the soils and rocks of the project area for the detailed design and engineering of all earthworks.
- Design layout and specifications for all the required earthworks to cost estimation requirements.
- Environmental and Social Impact Assessment.
- Estimation of the labour complement to operate the project.
- Preliminary design of the infrastructure required to support the mining, processing and construction operations.
- A study of the in-country road transport conditions.

18.2 RECOMMENDATIONS

18.2.1 Geology, Mineralisation and Exploration

The following recommendations for future geology, mineralisation and exploration studies to be undertaken during the next phase of the project have been made:

- There are discrepancies between the LiDAR survey generated digital terrain model and the drillhole collars, and it is recommended that a more accurate topographic survey is completed before the next resource estimate.
- The downhole surveying method employed can be impacted by magnetic interference from the rocks and potentially the drill string. It is recommended that KEFI survey some holes, especially deeper holes, using a non-magnetic method (e.g. gyroscopic survey) to assess the impact of any magnetic interference on the azimuth measurements.
- For wet samples, Snowden recommends that KEFI use a cone splitter in future drilling programs as the current practice of spearing is incorrectly delimited and likely introducing a high sampling error.
- RC duplicate results show relatively poor precision and Snowden recommends that the RC splitting process be reviewed. Snowden notes that procedures are not well documented and it is recommended that KEFI develop official procedures associated with drilling, logging, sampling, sample preparation, assaying and quality assurance/quality control ("QA/QC").
- Snowden recommends that check assays be sent to an umpire laboratory on a regular basis and that standards be included in the batches sent.

18.2.2 Ore Reserves and Mining

The following recommendations for future mine planning and Ore Reserve studies to be undertaken during the execution phase of the project have been made:

- The degree of selectivity can be better quantified assessing the suitability of:
    - Dozer ripping in the saprolite and hard materials available at surface in field trials
    - Variable blast heights to leave behind contaminated material
    - Field trials of dozer pushing blasted material
    - Identification of any free dig in the saprolite in field trials
    - Detailed blasting timing / dynamics study to control movement as a specialised study and potentially with field trials

If any of the above modified mining methods prove productive then they will help minimise the effects of dilution.

- The mining costs for the study were developed using a new owner fleet for mobile plant, as supplied by the OEM. Second-hand mining fleet or the adoption of contract mining may reduce the mining costs, and these options should be investigated.

- Further exploration as infill drilling in the pit will only marginally add to the Ore Reserve as there is only a small amount of Inferred available. A program should be commenced to identify gold resources adjacent to the Tulu pit.

18.2.3 Tailings Storage Facility and Water Management System

Based on the design and supporting information available at the time of completing the updated DFS design and the updated life of mine plan, it is recommended that the subsequent phases of the project include the implementation of the measures identified for the pro-active mitigation of surface and groundwater contamination risks. These are in accordance with the precautionary principle as well as currently accepted practice and are expected to include, but not necessarily be limited to the following:

- The use of the in-situ materials beneath the TSF footprint to construct a layer of re-compacted low permeability clayey soils to reduce the rates of seepage to the foundation of the facility.
- The installation of a series of groundwater interception boreholes down gradient of the TSF to intercept and abstract potentially contaminated flow, to be returned to the plant or the TSF decant pool as process make-up water inputs.
- The design and construction of a passive treatment system to the downstream water course to treat post closure seepage flows and run-off from the TSF.
- The construction of an engineered cover to the crest of the TSF to reduce the rate of recharge to the facility, thereby reducing the mobility of potential contaminants within the facility.
- The construction of a post-closure decant system that will decant general monthly rainfall water and will provide a large decant capacity in an extreme storm event.

The implementation of the mitigation measures as described should be finalised in conjunction with the finalisation of the assessment of the tailings geochemistry, expected to include the following:

- Confirmation of the geochemical properties of the tailings with specific reference to the potential for AMD generation and leachability of contaminants as per the recommendations of the preliminary geochemistry assessment.
- Confirmation of the potential severity of groundwater contamination due to contaminated seepage from the TSF, based on the geochemical characterisation of the tailings and the outcome of the geohydrological assessment and associated contaminant transportation modelling.
- Confirmation of the geotechnical properties of the tailings based on laboratory testing of a representative sample.
- Confirmation of the availability of material from the open pit suitable for the construction of the starter embankment and subsequent raises to the containment wall.

Once the additional information is available, it is recommended that the detailed design of the TSF be finalised to include a detailed review of the pollution control measures and, specifically, the requirements for closure of the TSF. The finalisation of the TSF design should include the development of the necessary codes of practice and operating manuals to ensure the appropriate management and operation of the facility.

It is recommended that rates for the construction of the capital and rehabilitation and closure works be sourced either from suitably equipped and qualified local contractors or from international contractors with the capacity to carry out such works in Ethiopia.

Should the project proceed to implementation, it is recommended that the financial provisions for the development, operation and closure of the TSF be confirmed to include appropriate allowances for:

- The ongoing and final rehabilitation and closure of the facility.
- Monitoring of the quality of surface water both within the TSF system and in the diversion works to ensure that potential contamination of surface water outside of the TSF system is detected.
- Monitoring of the management of the return water system to ensure that it is operated in accordance with the intended philosophy of minimising storage in the TSF itself while maintaining sufficient storage to provide for ongoing plant make-up water requirements.
- Monitoring of the extent and quality of groundwater seepage emanating from the TSF site and its abstraction, if necessary, by means of dewatering boreholes.

GENERAL DEFINITIONS

TERM	DEFINITION
ALS	ALS Ltd. (Laboratory Services)
CLO	Community Liaison Officer
DFS	Definitive Feasibility Study
ESIA	Environmental and Social Impact Assessment
Ethiopia	Federal Democratic Republic of Ethiopia
GCA	Gravity Concentrators Africa
Golder	Golder Associates (Ghana) Ltd, engaged by KEFI to design the TSF and provide input to the ESIA for the purposes of the DFS
Government	Government of Ethiopia
JORC	Australasian Joint Ore Reserves Committee
JORC Code (2012)	Code for reporting of Mineral Resources and Ore Reserves, with the latest revised version being published by JORC in 2012
LOM	Life of mine
MoM	The Ministry of Mines of the Government
MoWR	The Ministry of Water Resources of the Government
KEFI	Kefi Minerals Plc
KME	Kefi Minerals (Ethiopia) Plc
Nyota (Ethiopia)	Nyota Minerals (Ethiopia) Limited
Nyota (UK)	Nyota Minerals (UK) Limited incorporated in England & Wales with registered number 04832551
OMC	Orway Mineral Consultants
PAP	Project Affected People
RAP	Resettlement Action Plan
SENET	SENET (Pty) Ltd
SIA	Social Impact Assessment
Synergy	Synergy Global Consulting Ltd, engaged by KEFIto provide input to the ESIA and RAP
TSF	Tailings Storage Facility
Tulu Kapi or the Project	Tulu Kapi gold project, with a mining licence area of 6.98 km^2, located in the Wellega Zone of Oromia Regional State in Western Ethiopia
Tulu Kapi Licence	Tulu-Kapi Mining Licence number MOM\LSML\81\2015

Tulu Kapi Exploration Licence	Tulu Kapi and Ankore Exploration Licence no. 127-128/97. Exploration licence for the current ML. Expired June 2014 and replaced by ML
WAI	Wardell Armstrong International, engaged by Nyota to provide a development and production programme for Tulu Kapi for the purposes of the DFS
VSAT	A very small aperture terminal (VSAT) is a two-way satellite ground station

TECHNICAL DEFINITIONS

TERM	DEFINITION
µm	micrometre
Ai	Abrasion Index
Atm	Atmospheric
Au	chemical symbol for gold
BV	bed volume
BWi	Ball Mill Work Index
°C	degree Celsius
CIL	carbon in leach
CIP	carbon in pulp
CMS	carbonaceous mudstone
CN_{WAD}	weak acid dissociable cyanide
CWi	Crushing Work Index
dB	decibel
dc	direct current
DD	diamond drill hole
DEM	digital elevation model
DGPS	differential global positioning system
DO	dissolved oxygen
DTM	digital terrain model
EGRG	
EPCM	engineering, procurement and construction management
EW	east west
FRP	fibre-reinforced polymer
g/m^3	gram per cubic metre

TERM	DEFINITION
g/mL	gram per millilitre
g/t	gram per tonne
GA	general arrangement (drawing)
GIS	geographic information system. A system designed to capture, store, manipulate, analyze, manage, and present all types of spatial or geographical data.
GPS	global positioning system
GRG	gravity-recoverable gold
h	hour
ha	hectare
HEP	hydroelectric plant
Hg	chemical symbol for mercury
IBC	intermediate bulk containers
ID	inside diameter
ILR	inline leach reactor
ISO	International Organization for Standardization
ISPS	International Ship and Port Security
J	joule
kg	kilogram
km	kilometre
km^2	square kilometre
kPa	kilopascal
kVA	kilovolt ampere
kWh	kilowatt hour
L	litre
LAN	local area network
LHD	load-haul-dump unit
LIDAR	Light Detection and Ranging
m	metre
m^2	square metre
m^3	cubic metre
m^3/h	cubic metre/hour
max.	maximum
min.	minimum
mm	millimetre

TERM	DEFINITION
mol %	mole per cent
mol wt	molecular mass (weight)
MoM	Ministry of Mines
MPS (P)	mineral processing separating (pumping)
Mt	million tonne
Mtpa	million tonne per annum
MW	megawatt
MWh	megawatt hour
No.	number
NPV	net present value
NW	northwest
Ø	diameter
oz	ounce;
ozt	troy ounce
PAS	process automation system
Pa	pascal
PFS	Pre-Feasibility Study
pH	The activity of hydrogen ions in a substance or solution (i.e. a measure of how acidic or basic a substance is)
PP	processing plant
ppb	part per billion
ppm	part per million
PSD	particle size distribution
QA	quality assurance
QC	quality control
RC	reverse circulation
RFP	Request for Proposal
ROM	run of mine (ore)
RWi	Rod Mill Work Index
s	second
S/S	stainless steel
SAG	semi-autogenous grinding
SABC	SAG and ball mill with pebble crushing
SCADA	supervisory control and data acquisition

TERM	DEFINITION
SG	specific gravity
SQL	Structured Query Language. A special-purpose programming language designed for managing data held in a relational database management system
t/h	tonne per hour
t	tonne
tpa	tonne per annum
tpd	tonne per day
UCS	Unconfined Compressive Strength
µm	micron
V	volt
v/v	volume by volume
vol	volume
w/v	weight by volume
w/w	weight by weight

GLOSSARY

TERM	DEFINITION
Adindan	The Ethiopia Adindan datum references the Clarke 1880 spheroid projection.
Albite	white (pale) feldspar mineral (chemical formula $NaAlSi_3 O_8$)
Amphibole	group of generally dark-coloured rock-forming minerals
Andesite	dark-coloured, fine-grained volcanic rock
Antimony	brittle grey metal with a flaky, crystalline texture
Archean	geological era between 4 600 and 2 500 million years ago
Arsenic	metallic, grey, brittle element (chemical symbol As)
Arsenopyrite	iron arsenic sulphide (chemical formula FeAsS), most common arsenic mineral and principal ore of arsenic
Ash	volcanic fragments of sharply angular (glass) particles
Atomic Absorption Spectrometry (AAS)	spectro analytical procedure for the quantitative determination of chemical elements
Auriferous	containing gold
Basalt	common extrusive volcanic rock, usually grey to black and fine-grained due to fast-cooling lava at the surface
Basement rock	rocks below a sedimentary platform or cover, or more generally any rock below sedimentary rocks or sedimentary basins that are metamorphic or igneous in origin
Biotite	common mineral within the mica group (approximate chemical formula $K(Mg,Fe)_3AlSi_3O_{10}(F,OH)_2$), more generally refers to the dark mica series
Blank	known QAQC sample with no trace of the desired element
Block Model	computer technique for estimation of grades for individual solid blocks in a regular three-dimensional array using sample data from drill holes or underground sampling
Bornite	sulphide mineral (chemical composition Cu_5FeS_4) and an important copper ore mineral
Boudinage	geological term for structures formed by extension
Calaverite	uncommon telluride of gold, a metallic mineral (chemical formula $AuTe_2$) with approximately 3 % of the gold replaced by silver
Cenozoic	geological era from 65 million years ago until the present
Chalcopyrite	copper iron sulphide mineral ($CuFeS_2$)
Chip/s	returned cuttings from RC drilling
CRM	Certified Reference Material – see Standard

TERM	DEFINITION
DGPS	Differential GPS is an enhancement to GPS that provides improved location accuracy, from the 15 m nominal GPS accuracy to approximately 10 cm in the case of the best implementation
Diamond Drilling (DD)	drilling method that recovers a 'stick' of rock by using a diamond cutting face on a hollow drilling tube
Digital Terrain Model (DTM)	digital model or 3D representation of a terrain's surface or topography
Diorite	grey to dark grey intermediate intrusive igneous rock
Dip	angle at which a planar feature is depressed from the horizontal
Dolerite	medium-grained igneous rock that originates at medium to shallow depths
Dry density	weight of a unit volume of a dry sample of soil/rock
Dyke	type of sheet intrusion referring to any geologic body that cuts discordantly across pre-existing rocks
EEPCo	Ethiopian Electric Power Corporation
Epidote	green-coloured rock-forming silicate mineral
Fault	fracture or break in a rock, along which there has been an amount of displacement
Feldspar	The most abundant group of rock forming silicate minerals in the crust.
Ferromagnesian	silicate mineral containing iron and/or magnesium
Fire Assay	assaying of gold and silver by methods requiring a furnace heat
Fissure	fracture or crack in a rock, along which there is a distinct separation
Flitch	mining term for small bench or lift in open-pit extraction
Galena	most important ore of lead (chemical symbol PbS) and source of silver
Geochemical	prospecting techniques which measure the content of specified elements in rocks and ; sampling defines anomalies for further testing
Geophysics	prospecting techniques which measure the physical properties (magnetism, conductivity, density, etc.) of rocks and define anomalies for further testing
Gneiss	banded rocks formed during high grade regional metamorphism
Granodiorite	coarse-grained igneous rock, intermediate in composition between granite and diorite
Greenstone	field name for compact, igneous rocks and sedimentary metamorphosed rocks of the Archaean age
Hanging wall	overlying side of an orebody, fault, or mine working, especially the wall rock above an inclined vein or fault

TERM	DEFINITION
ICP-AES	inductively coupled plasma atomic emission spectroscopy, also referred to as inductively coupled plasma optical emission spectrometry (ICP-OES), is an analytical technique used for the detection of trace metals
Ignimbrite	rock formed by the widespread deposition and consolidation of ash flows
Indicated Mineral Resource	An estimate of mineral resources made from geological evidence as defined by the2012 JORC Code for reporting ore reserves and resources. It means a mineral resource that has been sampled by drill holes or other sampling procedures at locations too widely spaced to ensure continuity but close enough to give a reasonable indication of continuity.
Induced Polarisation (IP)	geophysical survey technique in which a current is passed through the ground for the purpose of identifying conductive (chargeable) bodies and measuring the resistivity of sub-surface strata
Inferred Mineral Resource	An estimate of mineral resources made from geological evidence as defined by the JORC Code for reporting ore reserves and resources. It is inferred from geological evidence and assumed but not verified geological and/or grade continuity. It is based on information gathered through appropriate techniques from locations such as outcrops, trenches, pits, workings and drill holes which may be limited or of uncertain quality and reliability.
JK functions	
Light Detection And Ranging (LIDAR)	remote-sensing system used to collect topographic data collected with aircraft-mounted lasers capable of recording elevation measurements at a rate of 2 000 to 5 000 pulses per second and that have a vertical precision of 15 cm
Limestone	sedimentary rock composed largely of the minerals calcite and aragonite, which are different crystal forms of calcium carbonate ($CaCO_3$)
Mafic	generally dark-coloured, iron and magnesium rock-forming minerals
Magnetite	iron ore mineral (Fe_3O_4)
Measured Mineral Resource	An estimate of mineral resources from geological data as defined by the 2012 JORC Code for reporting ore reserves and resources. This is part of a mineral resource where exploration data are distributed in sufficient density and are of sufficient reliability to allow the estimation of the resource, volume, shape, tonnage and grade to a level of confidence in their accuracy to allow a detailed mining feasibility study to be carried out.

TERM	DEFINITION
Mesothermal	hydrothermal mineral deposit formed at intermediate temperatures (200 °C to 300 °C) and depth
Mesozoic	geological era from about 225 to about 65 million years ago
Metamorphic rock	rock which has undergone physical or chemical changes, or both, to achieve equilibrium with conditions other than those under which they were originally formed (excluding process of weathering). Agents of metamorphism are heat, pressure, and chemically active fluids.
Metasedimentary rock	sedimentary rock that shows evidence of having been subjected to metamorphic activity
Metasomatic	metamorphic change that involves the introduction of material from an external source
Metavolcanic rock	type of metamorphic rock, first produced by a volcano then buried and subjected to high pressures and temperatures, causing the rock to recrystallize. Commonly found in greenstone belts
Mineral Resource	A concentration of material of economic interest in or on Earth's crust in such form, quality and quantity that there are reasonable and realistic prospects for eventual economic extraction. The location, quantity, grade, continuity and other geological characteristics of a Mineral Resource are known, estimated from specific geological evidence and knowledge, or interpreted from a well-constrained and portrayed geological model. Mineral Resources are subdivided, in order of increasing confidence in respect of geoscientific evidence, into Inferred, Indicated and Measured categories. A deposit is a concentration of material of possible economic interest in, on or near the Earth's crust. Portions of a deposit that do not have reasonable and realistic prospects for eventual economic extraction must not be included in a Mineral Resource.
Mobile Metal Ion (MMI)	Especially well suited for deeply buried mineral deposits, MMI measures metal ions that travel upward from mineralisation to unconsolidated surface materials such soil, till, sand and so on.
Multiple Indicator Kriging (MIK)	advancement on other techniques for mineral deposit modelling and resource block model estimation (see ordinary kriging), and considered to more accurately estimate overall global mineral deposit concentrations or grades
Muscovite	(also known as common mica) most common mica, found in granites, pegmatites, gneisses, and schists, and as a contact metamorphic rock or as a secondary mineral typically resulting from the alteration of feldspar
Mylonite	fine-grained, compact rock produced by shearing and dislocation processes resulting in a reduction of the grain size of the rock. It is classified as a metamorphic rock

TERM	DEFINITION
Ordinary Kriging (OK)	most commonly used type of kriging, it assumes a constant but unknown mean
Palaeozoic	geological era from 570 to 245 million years ago (541-252.17)
Peneplain	low-relief plain representing the final stage of fluvial erosion during times of extended tectonic stability
Phanerozoic	of rocks younger than 590 million years (541 Ma +- 1 Ma)
Plagioclase	series of sodium/calcium feldspars, plagioclase feldspars are common rock-forming minerals
Precambrian	geological period before 570 million years (541MA)
Proterozoic	most recent of the three subdivisions of the Precambrian, spanning from 2 500 to 570 million years (541MA)
Pulp duplicate	very fine grain (as a result of grinding) sample of equal mass and mineral content
Pluton	body of intrusive igneous rock (called a plutonic rock) that crystallised from magma slowly cooling below the surface of the Earth; usually refers to a distinctive mass of igneous rock
Pyrite	Mineral compound of iron and sulphur, sulphide mineral, iron sulphide, chemical symbol FeS_2
Quality Assurance/ Quality Control (QAQC)	process or set of processes used to measure and assure the quality of a product/process that ensures that products and services meet user expectations
Quaternary	geological period spanning from approximately 2.5 million years ago to the present (2.588 to present)
Quartz	mineral composed of silicon dioxide formula SiO_2
Resistivity	measure of how strongly a material opposes the flow of electric current
Reverse Circulation (RC)	pneumatic drilling method in which the drill cuttings are returned to the surface inside the drill rods to minimise cross-contamination
Riffle	used in sample splitting, or reducing, whereby the sample is split into two equal streams as it falls across an assembly of deflecting chutes
Rhyolite	group of extrusive igneous rocks, typically porphyritic and commonly exhibiting flow texture, with phenocrysts of quartz and alkali feldspar in a glassy to cryptocrystalline groundmass
Sandstone	clastic sedimentary rock composed mainly of sand-sized minerals or rock grains
Saprolite	chemically weathered rock, formed in the lower zones of soil profiles and representing deep weathering of the underlying rock surface
Schist	medium-grade (regional) metamorphic rock characterised by a parallel arrangement of the bulk of the constituent minerals

TERM	DEFINITION
Sedimentary	formed by the deposition of material at the Earth's surface and within bodies of water
Selective Mining Unit	SMU -
Sericite	fine-grained white mica, similar to muscovite. Formula ($KAl_2(AlSi_3O_{10})(OH)_2$)
Sill	tabular sheet intrusion of igneous rock which conforms to bedding or other structural planes
Specific gravity (SG)	ratio of the density (mass of a unit volume) of a substance to the density (mass of the same unit volume) of a reference substance, typically water
Sphalerite	main zinc sulphide mineral (ZnS)
Standard	predetermined metallurgical sample with a known chemical/element content
Stockwork	three-dimensional network of planar to irregular veinlets
Strike	direction in which a horizontal line can be drawn, important in determining the direction in which to measure dip, also used for general trend or run of geological feature
Sulphide	mineral containing sulphur in its non-oxidised form
Syenite	coarse-grained, intermediate igneous rock characterised by the presence of alkali feldspars. Same general composition as granite but with the quartz either absent or present in relatively small amounts (< 5 %)
Sylvanite	also known as silver gold telluride, $(Ag, Au)Te_2$, is the most common telluride of gold
Tectonic	adjective used to relate to a particular phenomenon to a structural or orogenic concept; tectonics is the study of major geological/structural features
Telluride	term for the anion Te^{2-} and its derivatives; mineral that is a compound of a metal and tellurium
Tennantite	copper arsenic sulphosalt mineral (chemical formula $Cu_{12}As_4S_{13}$) that is grey-black, grey or black in colour
Tertiary	geologic period from 65 to 2.6 million years ago
Tetrahedrite	copper, iron, antimony sulphide mineral
Trench	elongated open-air excavation for the purpose of mapping and sampling
Tropari	single-shot, micro-mechanical borehole surveying instrument that is operated by a timing device. Hole direction is measured from the Earth's magnetic field and the Tropari provides both direction and inclination, which can be used to define the attitude of the borehole at the survey depth

TERM	DEFINITION
Ultramafic rock	igneous rock with very low silica content (less than 45 %), generally dark coloured, with a high magnesium and iron content, and composed of usually greater than 90 % mafic minerals
Universal Transverse Mercator (UTM)	geographic co-ordinate system that uses a two-dimensional Cartesian co-ordinate system to give locations on the surface of the Earth
Veins/veinlets	tabular or sheet-like body of minerals which has been intruded into a joint or fissure, or system of joints and fissures, in rock
Wireframe	visual presentation of a three-dimensional or physical object used in 3D computer graphics